How to measure cost of capital – an accounting academic's view

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About me

- At Rotman since 2010 – at Columbia, NYU prior to that
- Ph.D. from Harvard, MBA/B.Tech from IIM/IIT in India
- CPA-CGA, ICD.D, Former board member CGA Ontario
- Teaching
  - → MBA - Business Analysis and Valuation (2nd year elective)
  - → Undergraduate – Financial Statement Analysis
  - → PhD – Seminar on Valuation
  - → Executives – Finance & Accounting for non-Financial Executives (FANFE)
- Research
  - → How to value young, fast-growing firms
  - → How to measure the "implied" cost of capital
  - → How to identify winners/losers using financial statement signals
  - → Executive compensation and Governance

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Agenda for this presentation

- Conventional methods of measuring cost of capital
- More advanced methods of measuring cost of capital
- Implied cost of capital
- Cross-sectional forecasts
- Q&A (time permitting)

Conventional Method of Measuring Cost of Capital

- Most common and universally used method is the Capital Asset Pricing Method or CAPM

  → $E(R_i) = R_f + \beta_i * E(R_m - R_f)$

- Steps in using CAPM to measure cost of capital
  - → Figure out the risk free rate (R_f)
  - → Estimate systematic risk (β)
  - → Make an assumption about the market premium ($E(R_m - R_f)$)

- Each step involves making considerable assumptions

Problems with CAPM

- Risk free rate usually does not cause much of a problem
  - → general approach is to use the rate for a riskless asset with a similar horizon as the underlying cash flows being discounted
  - → Usually yield on an intermediate term treasury
  - → Challenges in foreign investments
- Biggest challenge is in estimation of β and assumption of market premium
  - → What returns to use for β estimation (daily, monthly, weekly)
  - → What horizon to use for β estimation
  - → Data issues – especially with daily returns
  - → Market premium assumption more a matter of faith

Fixing β estimation problems

- Different sources will give you different β estimates
- Different approaches will provide different β
- Tremendous outliers in β estimation
  - → What does a β of 5 or negative β mean
- One solution – portfolio estimation
  - → Step 1: Estimate β for entire population
  - → Step 2: Form portfolios based on estimated β
  - → Step 3: Estimate portfolio β
  - → Step 4: Assign portfolio β to each firm in portfolio

Market Premium Estimation

- To estimate Market Premium, you need assumptions about
  - → How far back you want to go?
  - → What return metric (annual returns, monthly returns annualized)?
  - → What mean – arithmetic, geometric, harmonic?
- Using data from 1928 to date, and monthly returns
  - → Arithmetic mean of $R_m - R_f$ 7.8%
  - → Geometric mean of $R_m - R_f$ 6.0%
  - → Harmonic mean of $R_m - R_f$ 4.1%
- Using data from 1963 to 2012, and monthly returns
  - → Arithmetic mean of $R_m - R_f$ 5.9%
  - → Geometric mean of $R_m - R_f$ 4.6%
  - → Harmonic mean of $R_m - R_f$ 3.3%
- So what is the market premium?
  - → Whatever you want it to be!

Fundamental Problem with β

- β is supposed to provide us with a measure of expected returns
- We use historical realized returns to estimate β
- However, β shows very low correlation with actual future realized returns
  - → Sequence of papers by Fama and French
  - → The size-effect and the Book-to-Market effect dominate
  - → Cannot be fixed by mere size-adjusted β
- Idiosyncratic risk appears to be priced
  - → Investors not as diversified as we think they are

Fama French Multi-factor Models

$$E(R_i) = R_f + \beta_{m,i} * E(R_m - R_f) + \beta_{SMB,i} * E(SMB) + \beta_{HML,i} * E(HML)$$

- where SMB and HML are factors that correspond to the size-effect and the book-to-market effect (returns to hedge portfolios)
- SMB stands for small minus big, HML stands for high minus low
- Each firm has 3 βs now
- Similarly, one need 3 equity risk premia to estimate now
- Things to Note
  - market β is not the same as the single-factor β as it is now estimated in a three factor model
  - negative β makes sense for SMB and HML factors – simply means a firm that is less risky than the average
  - high β_{SMB} does not always mean small firm and low β_{SMB} does not always mean large firm, though most small firms will have positive β, most large firms will have negative β
  - Similarly, high β_{HML} does not always mean high B/M firm and low β_{SMB} does not always mean low B/M firm.

Estimating the Fama-French 3-factor model

- Source of data – Ken French's data library http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
- For each firm run the following regression in the estimation period to estimate the βs

  $R_i = R_f + \beta_{m,i} * (R_m - R_f) + \beta_{SMB,i} *SMB + \beta_{HML,i} *HML$
- Estimate the equity risk premia for each of the factors as the average of historical returns
- Using monthly data from 1928-2010, annualized risk premia, using geometric means are : Market 6.0%, SMB 2.2%, HML 4%
- Estimate the cost of capital as

  $R_i = R_f + \beta_{m,i} * 6\% + \beta_{SMB,i} *2.2\% + \beta_{HML,i} *4\%$

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Using the Fama-French model

- FF 3-factor has become the default in academic research in accounting and finance
  - → You cannot claim to have a trading rule – unless you control for the FF risk factors (market, size, B/M).
  - → Works best in portfolio regressions
- Often augment FF risk factors with
  - → 4th factor for momentum (UMD or up minus down).
  - → Latest FF model has two additional factors – investment (CMA) and profitability (RMW)
- Problem with the FF model
  - → It is purely an empirical model – none of the factors are theoretically motivated
  - → In the original model, the factors emerged after a horserace with other variables – in different settings, others may be appropriate (E/P, Leverage)
  - → For some of the factors, it is unclear whether they represent risk or mispricing (B/M, Momentum)
  - → Tough to interpret when some factors have negative premia for significant periods (size effect in recent times)

Implied Cost of Capital (ICC)

- What does the market tell us what the cost of capital is?
- Infers discount rate from current price
- Needs the following pieces of information
  - → Price
  - → Some estimate of future earnings/cash flows – usually from analyst forecasts
  - → Terminal Value assumption
- What is the discount rate that makes Price equal Value?
- Prior research has estimated ICC in a variety of methods
  - → Residual Income Valuation Method
  - → Capitalized Abnormal Earnings
  - → Target Prices

Why is ICC useful

- Implied cost of capital is a summary statistic for all priced risk
  - → Risk is multi-faceted, multi-factor notion
  - → ICC measures priced risk, irrespective of its source
  - → Research show that ICC is correlated with what we would consider risk factors (β +, unsystematic risk +, leverage +, size - , B/M +, analyst following -, forecast dispersion +, growth +)
- One can compare implied costs of equity for firms to get a sense of relative valuation
  - → Low implied cost of capital : a firm that is either less risky, or is favored by the markets
  - → High implied cost of capital : a firm that is more risky or disfavored by the markets

Implied Cost of Equity in practice

- Regulators have often used an ICC metric without labelling it as such
  - → The US STB was using an "implied" cost of capital method to calculate the railroad's cost of capital
  - → However – they used the Gordon growth model
  - → $P = E/(r-g) \Rightarrow r = E/P + g$
  - → Works only when firms are close to steady state and g is terminal growth ($g < r$)
- They switched over to a CAPM based method in 2008
  - → I argued, in a tabled submission, that they were trading a bad method for a worse one
  - → May be better to use an implied cost of capital method that allows for intermediate growth rates to exceed r
  - → We will discuss one such method next

Different approaches to estimate ICC

- There are many ways to estimate ICC. However all approaches need
  - → Current Stock Price
  - → Estimates of short run earnings/cash flows
  - → Estimates/assumptions of long run/terminal growth rates
- Commonly used ICC approaches
  - → Based on Residual Income Valuation Model
  - → Based on Abnormal Earnings Growth Model
  - → Based on Target Prices and dividends
- In theory all models should give the same answer
  - → All are based on the same theory – all start from the dividend discount model
  - → In practice they wont – different assumptions

RIV based approach

- Based on the residual income valuation model

$$V_t^* = B_t + \sum_{i=1}^{\infty} \frac{\mathrm{E}_t[NI_{t+i} - (r_e\, B_{t+i-1})]}{(1+r_e)^i}$$

$$= B_t + \sum_{i=1}^{\infty} \frac{\mathrm{E}_t[(ROE_{t+i} - r_e)\, B_{t+i-1}]}{(1+r_e)^i},$$

- Use analyst forecasts, "clean surplus assumption" and dividend assumption for future book values
- Terminal value based on future abnormal earnings tending to zero or future ROEs converging to industry median
- ICC is estimated numerically – i.e. what discount rate makes value equal price
- See Frankel and Lee (1998), Gebhardt, Lee and Swaminathan (2001), Claus and Thomas (2001)

Abnormal Earnings growth approach

- Based on the Ohlson and Juettner (2005) model
- A generalization of the Gordon growth model with two growth rates
  - → "g" is the short run growth rate (what analysts call the 5 year EPS growth rate)
  - → 'γ" is the 1+terminal growth rate
  - → Innovation is that "g" can be higher than the cost of equity, as is commonly the case
- This model provides a closed form solution for ICC

$$r_e = A + \sqrt{A^2 + \frac{\text{eps}_1}{P_0}(g_2 - (\gamma - 1))}$$

$$\text{where } A \equiv \frac{1}{2}\left((\gamma - 1) + \frac{\text{dps}_1}{P_0}\right) \text{ and } g_2 = \frac{(\text{eps}_2 - \text{eps}_1)}{\text{eps}_1}$$

Note that the expression above yields the Gordon growth model if $\text{dps}_t = k^*\text{eps}_t$ and $g_2 = \gamma - 1$.

Simplified Heuristic for ICC

- The "full form" OJ model can be simplified
  - → Ignore dividends
  - → Ignore terminal growth rate ($\gamma = 1$)

$$r_e = \sqrt{\frac{g}{(\mathrm{Pr}\,ice / eps_1)}}$$

- Implied cost of capital is the square root of the inverse of PEG

- This heuristic provides a closed form solution for ICC that is
  - → Simple
  - → Uses limited data
  - → Works quite well (as research indicates)

An Example : AAPL (April 12, 2017)

- Stock price is 141.35, Estimate of EPS_1 is 8.95, Estimate of long term growth is 9.25%
- r_e = sqrt (0.0925/(141.35/8.95)) = 7.64%
- How does that compare to CAPM?
  - → β = 1.44, rf = 2%, market premium 5%
  - → Cost of capital : 2% + 1.44*5% = 9.20%
- Market is discounting AAPL less than CAPM
  - → AAPL is less risky than CAPM indicates OR
  - → AAPL is undervalued OR
  - → Analysts are more bearish than the market (which expects higher EPS or growth)

Target price approach

- Target prices can be viewed as expected future prices
- View
  - → current price as the investment in time zero
  - → expected dividends in between as intermediate cash flows
  - → Target price as future value
- Solve for the discount rate
- Used in Botosan and Plumlee (2002) and Brav et al. (2005)

Which ICC approach works best?

- How do you evaluate ICC proxies?
  - → Correlation with conventional risk proxies
  - → Correlation with future returns
- Evidence is mixed
- Approaches have their pros and cons
  - → RIV based approaches rely on book value – stable but not sensitive
  - → OJ based models – sensitive but not stable
  - → Target price approach – data limitations
- In practice, researchers use average of measures from first two approaches

Problems with ICC

- Relies on analysts forecasts
  - → Research has shown that forecasts are often biased and often stale
  - → Don't represent market expectations
  - → ICC estimates also don't correlate well with stock returns
- Is it picking up risk or mispricing?
  - → Low ICC => overvalued => low returns
  - → High ICC => undervalued => high returns
- Fixes
  - → Don't use analyst forecasts (use regression based models to generate forecasts) – HVZ 2012, Li and Mohanram 2014
  - → Fix analysts forecasts – Mohanram and Gode 2013

Use of ICC for asset allocation

- ICC is a good proxy for time-varying expected returns
  - → Aggregate ICC predicts returns (Li, Ng, Swaminathan 2013)
  - → Can be used to measure time varying market premium
- However, there remains an identification problem
  - → High ICC => High Risk => High returns
  - → High ICC => Underpriced (overdiscounted) => High returns
- Can be viewed as a measure of market sentiment

ICC for firms without forecasts

- How does one calculate ICC for firms without forecasts?
- Generate your own forecasts
  - Time series models – wont work as the firms without forecasts are firms without a lengthy forecast
  - Cross-sectional models – have become very common in academic research (HVZ 2012, Li and Mohanram 2014)
    - Run a regression estimation model on a wide cross-section of firms
    - Use fundamental information such as Earnings, Book Values and Accruals
    - Firm does not need to be present in entire estimation period
  - While quite error prone, they work very well in large samples and generate unbiased forecasts

Implied Cost of Capital references

- Brav,A., Lehavy, M. and R. Michaely. (2005) Using Expectations to Test Asset Pricing Models. Financial Management 34: 31-64.
- Botosan, C. and M. Plumlee. 2002. A re-examination of disclosure level and expected cost of equity capital. Journal of Accounting Research 40 (1): 21–40.
- Claus, J., and Thomas, J. (2001). Equity risk premium as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stocks. Journal of Finance 56: 1629–1666.
- Gebhardt, W., Lee, C., and Swaminathan, B. (2001). Towards an implied cost of equity. Journal of Accounting Research, 39: 135–176.
- Gode, D. and Mohanram, P. (2003). Inferring the cost of equity using the Ohlson-Juettner model. Review of Accounting Studies, 8: 399–431.
- Hou, K., van Dijk, M., and Y. Zhang. (2012). The Implied Cost of Equity: A New Approach. Journal of Accounting and Economics 53: 504-526.
- Li, K. and Mohanram, P. (2014). Evaluating cross-sectional forecasting models for implied cost of capital. Review of Accounting Studies 19: 1152-1185.
- Li, Y., Ng, D. and Swaminathan, B. (2013) Predicting market returns using aggregate implied cost of capital. Journal of Financial Economics 110: 419-436.
- Mohanram, P. (2007), Determining an Appropriate Cost of Capital for Railroads, Submission to the Surface Transport Board Hearings, Aug 2007.
- Mohanram, P and Gode, D. (2013). Removing predictable analyst forecast errors to improve implied cost of equity estimates . Review of Accounting Studies 18: 443-478.
- Ohlson, J. and Juettner-Nauroth, B. (2005). Expected EPS and EPS growth as determinants of value. Review of Accounting Studies 10: 349-365.

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Conclusions

- Measurement of cost of capital is among the most important topics in the area of valuation
- Conventional CAPM based methods have serious drawbacks
- More advanced methods based on multi-factor models may address some of the problems
- Implied cost of capital may provide an easy to use alternative
  - → Can be used in conjunction with traditional methods
- Probably the best to measure cost of capital using a variety of techniques and take the average

My Current Research

- My current research is largely in the area of valuation and fundamental analysis
- Current working papers
  - → Fundamental Analysis: Combining the Search for Quality with the Search for Value
  - → Fundamental Analysis of Banks: The Use of Financial Statement Information to Screen Winners from Losers
  - → Can Twitter Help Predict Firm-Level Earnings and Stock Returns?