Estimating the Cost of Capital Using the CAPM

John C. Handley
Department of Finance
University of Melbourne

Melbourne Centre/ACCC Occasional Seminar Series
16 October 2007

1. THE PROBLEM OF ESTIMATION

- The cost of capital is unobservable and so the "true" value can only be estimated

- Two dimensions to estimation:

  (i) Which model should we use ?
  (ii) How should we estimate the model's parameters ?

- Parameter estimates associated with any model are always subject to limitations associated with data and econometric/statistical methodologies

- The choice of model includes a number of versions of the CAPM

- Focus here is on two issues which are too often underestimated (or even ignored??) when using a CAPM model:

  (i) equilibrium
  (ii) consistency

- Inherent imprecision of estimates → materiality considerations are always important

2. A SNAPSHOT OF SOME POPULAR VERSIONS OF THE CAPM

2.1 The Sharpe-Lintner (Standard) CAPM

- The relationship between the expected return and risk of an asset is given by:

$$E\left(r_j\right) = r_f + \beta_j\left(E\left(r_M\right) - r_f\right)$$

where

$E\left(r_j\right)$ is the expected return on asset j; r_f is the riskfree rate of return; $E\left(r_M\right) - r_f$ is the expected market risk premium; and β_j is the beta of asset j

- The model is based on a number of simplifying assumptions including: (i) investors can fully diversify at no cost; and (ii) no taxes.

2.2 The Brennan CAPM

- Extends the standard CAPM to allow for heterogeneous and differential personal taxes on dividends and capital gains under a classical tax system

- The relationship between the expected (after company before personal tax) return and risk of an asset is given by:

$$E\left(r_j\right) = r_f + \beta_j\left(E\left(r_M\right) - r_f - T\left(\delta_M - r\right)\right) + T\left(\delta_j - r\right)$$

where

δ_j is the dividend yield on asset j; δ_M is the dividend yield on the "market portfolio"; and T is the "aggregate tax factor"[1]

[1] It can be shown that the aggregate tax factor is a complex weighted average of tax rates and the levels of risk aversion across individual investors

2.3 Imputation-adjusted CAPMs

- The various models can be distinguished by their different assumptions concerning:

  (i) investor preferences (i.e essentially whether based on Sharpe-Lintner or Brennan

  (ii) investors' valuation of franking credits

	Preferences defined over before personal tax returns	*Preferences defined over after personal tax returns*
Heterogeneous value of franking credits	Officer (1994) Wood (1997) Handley & Maheswaran (2005)	Monkhouse (1993) Lally (1992), (2000) Lally & van Zijl (2003)
Homogeneous value of franking credits	–	Ashton (1989) Cliffe & Marsden (1992) Okunev & Tahir (1994) Brailsford & Davis (1995)

2.3.1 The Officer CAPM

- Assumes the standard model would apply with returns grossed up to include the "value" of franking credits:

$$E\left(r_j^G\right) = r_f + \beta_j\left(E\left(r_M^G\right) - r_f\right)$$

where

$E\left(r_j^G\right)$ is the expected (after company before personal tax) grossed-up return on asset j; r_f is the riskfree rate of return; $E\left(r_M^G\right) - r_f$ is the expected grossed-up market risk premium; and β_j is the beta of asset j

2.3.2 The Brennan-Lally CAPM

- Extends Brennan's CAPM to allow for heterogeneous and differential personal taxes on dividends, capital gains and interest under an imputation tax system

- Gives effect to imputation by allowing each investor's personal tax rate on dividends to vary across firms

- The expected return/pricing equation is similar to Brennan but there are three "aggregate tax factors" rather than one

3. MY VIEW

- No intention of arguing in favour of one model over another
- All the assumptions underlying the CAPM (or any model for that matter) are open to challenge
- No model is perfect
- The primary role of a model is to set the framework for estimation
- The alternative to such a framework is guesswork
- Two critically important issues for cost of capital estimation are: (i) equilibrium; and (ii) consistency

3.1 Equilibrium

- The market is in equilibrium when the demand (for assets) equals the supply (of assets)

- The relevant question for valuation purposes is what is the equilibrium value (or expected rate of return) of an asset?

- This can only be determined using a formal equilibrium asset pricing model … such as the CAPM

- Some important features of market equilibrium:
  - if you use the CAPM then implicitly you are assuming the market is in equilibrium
  - all investors agree on the equilibrium value of each asset otherwise the market is not in equilibrium, by definition
  - the equilibrium value of all assets in the "market" are determined jointly relative to all other assets in the "market" by all investors in the "market" i.e. neither individual assets nor individual investors are considered in isolation or equivalently there is no segmentation within the "market"
  - the equilibrium value of an asset reflects the collective "market consensus" concerning the relevant pricing factors (such as risk)
  - it is somewhat misleading, within the CAPM framework, to talk of the marginal investor since all investors collectively determine the prices of all assets and therefore all investors are collectively "the marginal investor"

3.1.1 Example: The Value of Franking Credits

- It can be shown that the Sharpe-Lintner CAPM may also be expressed as:

$$E\left(r_j\right) = r_f + \lambda\sigma_{jM}$$

where σ_{jM} is the covariance between the returns on asset j and the market and λ is the expected market price of risk

Importantly, λ measures the aggregate level of risk aversion in the economy (in equilibrium) …. which in turn is a complex weighted average of the level of risk aversion of all individual investors in the "market"

- Similarly, it can be shown that <u>in equilibrium</u>, Officer's CAPM is more precisely:

$$E\left(r_j + \gamma\zeta_j\right) = r_f + \beta_j\left(E\left(r_M + \gamma\zeta_M\right) - r_f\right)$$

where ζ_j is the franking credit yield on asset j; ζ_M is the franking credit yield on the "market portfolio"; and γ is the (equilibrium) value of franking credits

Importantly, γ is a complex weighted average of the value of franking credits across all investors in the "market"[2]

This interpretation is consistent with λ in the Sharpe-Lintner CAPM and T in the Brennan CAPM

[2] Handley and Maheswarn (2005). If the "domestic" market (to which the model is being applied) is assumed to be segmented from the world market, then the market portfolio is a portfolio of domestic stocks only and γ is a weighted average over all investors in the domestic market, including foreign investors <u>to the extent that they invest domestically</u>. If the domestic market is assumed to be integrated, then the market portfolio is a world portfolio of stocks and γ is a weighted average over all investors in the world market.

3.2 Consistency

- Once a model has been agreed then we have a statement as to which factors are to be taken into account for pricing purposes

- Need ensure parameters are:
  - consistent with the model
  - consistent with each other
  - interpreted in an equilibrium context

- This dimension of consistency is additional to the usual requirement that, within the WACC framework, cashflows and discount rates should be defined on a consistent basis

- For example, it is inconsistent to:

  - measure returns on individual stocks grossed up for the value franking credits but not gross up the return on the market portfolio

  - argue that the value of franking credits to a particular investor is important for pricing purposes but still measure returns relative to the "market"

- argue that franking credits have a zero value but still measure returns relative to a domestic "market"

- It is often argued that CAPM determined rates of return should be adjusted for (one or more) of the following factors:

  - Skewness in returns
  - Unsystematic risk
  - Asymmetric risks
  - Liquidity
  - Real options considerations

  Observed market prices should already reflect these factors, but ….

  - if compensation for these or other factors is to be allowed, then the only logical way by which this should proceed is to use an appropriate alternative asset pricing model.

  - No role for ad hoc adjustment to the CAPM determined rates of return since by definition this would be arbitrary

3.2.1 Example: The Pricing of Liquidity Risk

- A number of alternative liquidity-adjusted CAPMs have been developed.

  For example, Liu (2006) presents a two factor augmented CAPM that includes a market factor (like the standard CAPM) and a liquidity factor such that:

$$E\left(r_j\right) = r_f + \beta_j^M \left(E\left(r_M\right) - r_f\right) + \beta_j^L E\left(LIQ\right)$$

  where $E\left(r_M\right) - r_f$ is the expected market risk premium, $E\left(LIQ\right)$ is the expected liquidity risk premium, β_j^M measures the sensitivity of asset j to the market factor and β_j^L measures the sensitivity of asset j to the liquidity factor.[3]

  Of course, this should not be interpreted as suggesting the CAPM should be replaced with such a model.

[3] Along similar lines to the three factor model of Fama and French (1992), (1993) the liquidity factor is proxied by the return on a low liquidity portfolio less the return on a high liquidity portfolio. Liu (2006) argues that liquidity becomes a relevant issue when the economy is in or is expected to be in a recessionary state and so, risk averse investors prefer to invest in less risky, more liquid assets. When the economy performs poorly, causing liquidity to be low, investors require a high liquidity premium to compensate them for bearing high liquidity risk