The Calculation of the Cost of Capital
A Report for South East Queensland Water Businesses

Bruce D. Grundy

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1. My full name is Bruce David Grundy. I am a Professor of Finance in the Department of Finance at the University of Melbourne. I received my PhD in Finance from the University of Chicago and before joining Melbourne I was a faculty member at Stanford and Wharton and a visiting Professor at Chicago, Goethe-Universität Frankfurt am Main and Singapore Management University. I have taught subjects in *Corporate Finance*, *Derivatives*, *Real Options*, *Corporate Governance* and *Financial Management for Executives* at the undergraduate, masters and doctoral levels as well as executive education classes. I have served as Managing Editor of the *International Review of Finance* and Associate Editor of the *Journal of Finance*, *Review of Financial Studies*, *Journal of Financial and Quantitative Analysis*, *Journal of Financial Research* and *Accounting and Finance*. I have published extensively on the convertible bond market, dividend policy, corporate governance, option pricing, momentum trading strategies, and rational expectations models. I have consulted for investment banks, corporations, mutual funds and regulators in both the US and Australia. I am a Fellow of the Australian Society of Certified Practicing Accountants, a founding member of the Financial Integrity Research Group, a member of the Australian Centre for Financial Studies and convener of the Melbourne Derivatives Research Group. My curriculum vitae appears in Schedule 1 to this Statement.

Issues addressed in this Report

2. The calculation of the cost of capital involves numerous steps. The issues addressed in this report are:

2.1 The theoretical limitations of the Sharpe CAPM as a measure of the cost of equity.

2.2 The empirical limitations of the Sharpe CAPM as a measure of the cost of equity.

2.3 An estimate of the cost of equity that is consistent with the empirical evidence.

2.4 The relation between the cost of equity and the cost of debt.

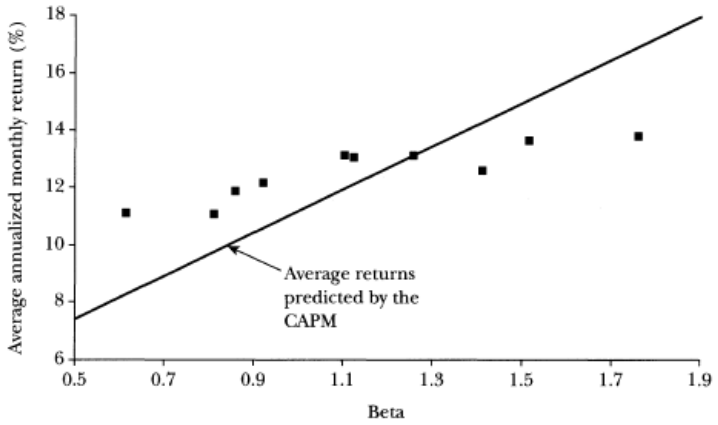
THEORETICAL LIMITATIONS OF THE SHARPE CAPM

3. Whether a model gives useful predictions is an empirical question. The fact that the Sharpe-Lintner CAPM relies on a number of simplifying assumptions does not in itself invalidate the model. But when a model does not accurately describe the data it is intended to explain it can be useful to examine the model's assumptions. The key empirical finding of the asset pricing literature is summarised in the figure reproduced below from Fama and French (2004)[1] which demonstrates graphically that low beta stock earn more than predicted by the Sharpe CAPM (and vice versa for high beta stock). The upward sloping line in the figure immediately below depicts the relation between average returns and betas as predicted by the Sharpe CAPM. The actual relation is depicted by the boxes.

[1] Fama, Eugene F. and Kenneth R. French, 2004, "The capital asset pricing model: Theory and evidence," *Journal of Economic Perspectives* 18, pp. 25-46.

Figure 2

Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on Prior Beta, 1928–2003



4. It can be seen that the lower the beta estimate used in the Sharpe CAPM, the more that model underestimates actual returns. According to the Sharpe CAPM the cost of equity, Re, is predicted to be

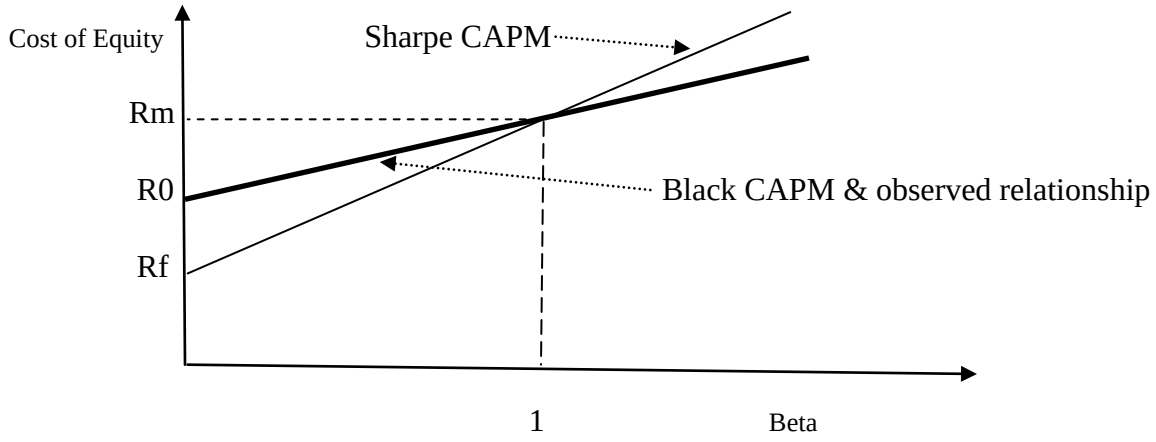
$$Re = Rf + \beta(Rm - Rf), \quad (1)$$

where β is the beta of equity, Rm is the expected on the market as a whole, and Rf is the risk-free rate. Beta is a measure of relative risk. If a stock has a beta of 2 it means that a 1% more (less) than expected return on the market as a whole will tend to be associated by a 2% more (less) than expected return on that stock. In practice average returns on stocks are better described by the relation

$$Re = R0 + \beta(Rm - R0), \quad (2)$$

where R0 is the return on a zero beta stock.

FIGURE 1: The Sharpe CAPM (depicted by the more-steep thin upward sloping line) and the Black CAPM & the empirical relation between the cost of equity and beta (depicted by the less-steep thick upward sloping line).



Black (1972) [2] was the first to relax the assumptions of the Sharpe CAPM and the model he developed, the Black CAPM, provides a better fit to the data. The Black CAPM predicts that the cost of equity for a zero beta stock will exceed the risk-free rate. In contrast, the Sharpe CAPM predicts that the cost of equity for a zero beta stock is equal to the risk-free rate.

Sharpe CAPM Assumption: Borrowing & lending rates are equal

5. Black's insight was to examine the implication of the fact that investors must pay higher rates to borrow than they could earn by lending to the government. The Sharpe CAPM assumes that investors can borrow on the same terms as the government. Black's insight was to see the implication of higher borrowing rates then lending rates, namely that:

> **The cost of equity for zero beta stock will exceed the risk-free rate and the cost of equity for all stock with betas less than (greater than) one will exceed (be less than) the cost predicted by the Sharpe CAPM.**

[2] Black, F., 1972, "Capital market equilibrium with restricted borrowing," Journal of Business, 1972 (45), pp. 444-454.

Sharpe CAPM Assumption: Transactions costs are zero

6. The Sharpe CAPM assumes that there are no brokerage costs, bid-ask spreads or information differences between traders; in short markets are perfectly liquid and traders can buy and sell shares costlessly. In practice, different securities involve different costs to trade them and lower trading cost, more liquid securities are more valuable all else equal. This can be seen most clearly in the higher price of more liquid, lower transaction cost "on-the-run" bonds versus less liquid bonds backed by the same issuer. This phenomenon has been well-documented in many countries. (See, for example, Boudoukh and Whitelaw (1993).[3]) The yield on the higher-priced, more-liquid bond issues is lower than the yield on less-liquid, otherwise equivalent bonds. Differences in liquidity have also been shown to similarly affect average returns on equities—see, for example, Lubos and Stambaugh (2003).[4]

7. The implication for the cost of equity is that investors in zero beta equity will demand a higher return than the risk-free rate paid on liquid government securities.; i.e., R0 > Rf. Trading equities involves higher transaction costs than trading governments bonds. The equity market is less liquid than the government bond market. Note that Rm naturally reflects the effect of the liquidity of the typical stock. The market risk premium measured as the difference between the return on the market and the return on zero beta equity (i.e., measured as Rm – R0) will be smaller than the market risk premium measured as Rm – Rf.

8. The implication of recognizing the effect of transactions cost on the cost of equity is that:

> **The cost of equity for zero beta stock will exceed the risk-free rate and the cost of equity for all stock with betas less than (greater than) one will exceed (be less than) the cost predicted by the Sharpe CAPM.**

[3] Boudoukh, J., and R. Whitelaw, 1993, "Liquidity as a choice variable: A lesson from Japanese government bond market" *Review of Financial Studies* 6, pp. 265-292.

[4] Pastor, L., and R. F. Stambaugh, 2003. "Liquidity Risk and Expected Stock Returns," Journal of Political Economy, 111(3), pp. 642-685.

Sharpe CAPM Assumption: The market contains all equities, bonds and real estate

9. Most empirical investigations of the CAPM treat the stock market as if it were the entire portfolio of all assets in the economy held by investors. The market portfolio in the Sharpe CAPM is in fact the portfolio of all equities, bonds and real estate in the economy. Implementations that use as a proxy for the entire portfolio of all assets only the equity component of those assets are vulnerable to what has become known as the Roll critique (Roll (1977)).[5]

10. Roll (1977) shows that for any efficient portfolio it is a mathematical truism that the cost of equity for any given stock is given by

$$Re = R0^E + \beta^E(R^E - R0^E), \qquad (3)$$

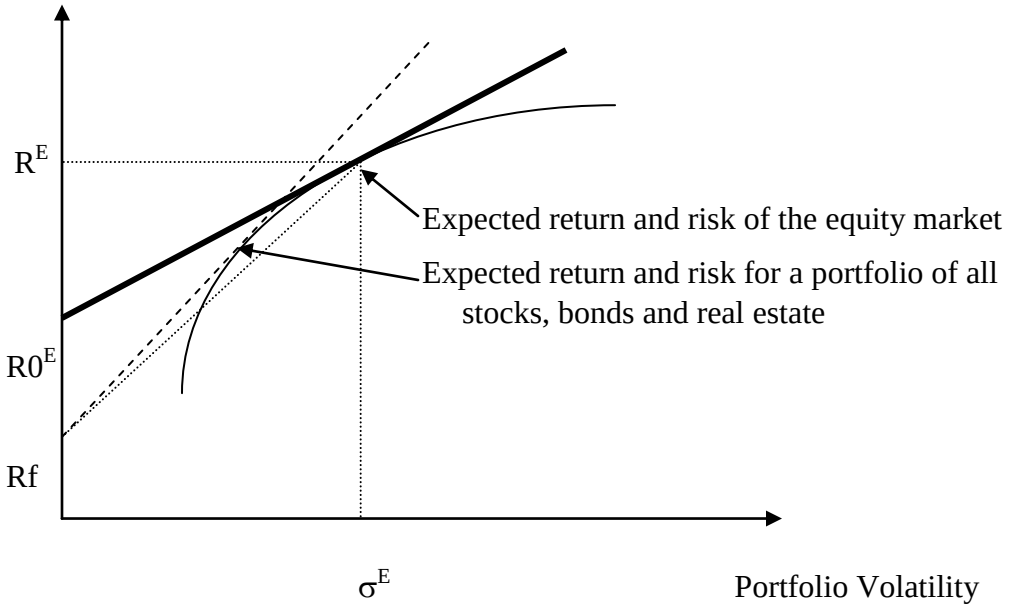
where $R0^E$ is the average return on any stock that has zero beta with respect to the return on that efficient portfolio (i.e., does not covary with that efficient portfolio), β^E is the beta of the given stock measured with respect to the return on that efficient portfolio, and R^E is the average return on that efficient portfolio. A portfolio is an efficient portfolio if it is the portfolio with the minimum volatility within the set of all portfolios with a given level of expected return.

11. The relation set out in the preceding paragraph takes the same form as the Sharpe CAPM. The import of the Sharpe CAPM is that, under its assumptions, the true market is an efficient portfolio and the expected return on all stock with a zero beta measured with respect to the true market is equal to the risk-free rate.

12. The figure below depicts a set of efficient portfolio and one particular efficient portfolio. The well-diversified portfolio of all equities is likely to be a close to efficient portfolio. It will though be more volatile than the volatility of the true market, and its expected return will be greater than the expected return on the true market.

[5] R Roll, R., 1977, "A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory," *Journal of Financial Economics* 4(2), pp. 129–176.

FIGURE 2: The Set of Efficient Portfolios and the Expected Return and Volatility of the Well-Diversified Equity Market as a Proxy for an Efficient Portfolio



13. If the well-diversified portfolio of all stocks is a good proxy for an efficient portfolio then equation (3) can be rewritten as

$$Re = R0 + \beta(Rm - R0),$$

where Rm is the average return on the equity market rather than the true market portfolio; i.e., equation (3) can be rewritten in the form of the Black CAPM. Note that the average return on the equity market will exceed the average return on the true market and in turn the average return on stocks that have zero beta with respect to the equity market will exceed the risk-free rate; i.e, R0 > Rf.

14. The implication of recognizing that the market in the Sharpe CAPM is the portfolio of all assets in the economy, not just the equities in the economy is that:

> **The cost of equity for zero beta stock when the equity market is used as a proxy for the entire market will exceed the risk-free rate and the cost of equity for all stock with betas with respect to that proxy less than (greater than) one will exceed (be less than) the cost predicted by the Sharpe CAPM.**

Sharpe CAPM Assumption: Investors live for one period only

15. The Sharpe CAPM assumes that investors consume their entire wealth at the end of the single investment period. Investors are assumed to allocate their investments across assets and borrow or lend in order to maximize the expected utility from consuming their entire wealth at the end of the period. High beta stock tend to payoff more when the market has done well and hence high beta stock will typically make their biggest contribution to end-of-period consumption when the investor's consumption from the remainder of his/her assets is already high. (The investor consumes everything at the end of the period).

16. The intuition underlying single-period asset pricing models is straightforward. High beta stocks give their best payoffs in states of the world where an extra unit of consumption has relatively little marginal value. In contrast, low beta stock will not have as strong a tendency to achieve their best just when additional consumption has relatively little marginal value. Thus for the same level of expected end-of-period payoff, investors will be willing to pay more at the beginning of the period for low-beta stock than they will pay for high-beta stock. Equivalently, investors require a lower return from low-beta stock than they will require from high-beta stock.

17. In practice, investors consume and invest throughout their lifetimes. At the end of each period, they allocate their wealth between current consumption and continued investment for future consumption and allocate the reinvested amount across different stocks and they also borrow or lend. Recognition of the inherently multi-period nature of investment decisions underlies the Consumption CAPM of Breeden (1979).[6] The Consumption CAPM describing expected returns over any one period takes the form

$$\text{Re} = \text{Rf} + \frac{\text{cov}(\text{Re},\ \%\ \text{change in consumption})}{\text{cov}\ (\text{Rm},\ \%\ \text{change in consumption})}(\text{Rm} - \text{Rf})\,.$$

Note that the correct risk measure when investors live for more than one period is not

[6] Breeden, D.T., 1979 "An intertemporal asset pricing model with stochastic consumption and investment opportunities," *Journal of Financial Economics* 7, pp. 265-296.

given by the beta risk measure of the Sharpe CAPM, β.

$$\frac{\text{cov}(\text{Re},\ \%\text{ change in consumption})}{\text{cov (Rm},\ \%\text{ change in consumption)}} \neq \beta \equiv \frac{\text{cov}(\text{Re},\ \text{Rm})}{\text{cov (Rm},\ \text{Rm)}} = \frac{\text{cov}(\text{Re},\ \text{Rm})}{\sigma^2(\text{Rm})}.$$

Only in a single period setting will the two risk measures be the same: In a single period setting consumption at the end of the period is equal to wealth at the end of the period which in turn is equal to the value of the market portfolio of the period

18. An equivalent way of thinking about the multi-period consumption investment problem is to recognize that an investor is interested not only in whether a particular stock tends to payoff when the market as a whole is doing well, but also in whether there is tendency for the stock to have higher or lower payoffs when reinvestment opportunities are good. Not only will co-movement with the return on the market be important, but co-movement with changes in future interest rates, changes in future market risk premiums and changes in future market volatility, and other changes in the investment opportunity set will be important. Thus a stock's risk will have many dimensions beyond the simple beta risk measure of co-movement with the return on the market. This way of viewing the multi-period consumption-investment problem is the basis for the Intertemporal CAPM first developed in Merton (1973).[7]

19. While the Fama-French (2004) model has been criticised as lacking a strong theoretical basis, it can be interpreted as an empirical determination of measures of co-movement with changes in the investment opportunity set that affect investors' required returns. The observation that in practice R0 (the average return on zero beta stock) exceeds Rf can be interpreted as consistent with zero beta stock having sensitivities to changes in the investment opportunity set that add to their required return.

20. The implication of recognizing the multi-period nature of consumption and investment decisions in practice is that if investors recognize the possibility of changes in future investment opportunities when choosing their optimal portfolios then:

[7] Merton, R.C., 1973, "An intertemporal capital asset pricing model," *Econometrica* 41(5), pp. 867-887.

The cost of equity for zero beta stock can exceed the risk-free rate and the cost of equity for all stock with betas less than (greater than) one can exceed (be less than) the cost predicted by the Sharpe CAPM.

EMPIRICAL LIMITATIONS OF THE SHARPE CAPM

21. I know of no published study that has empirically tested the Sharpe CAPM and failed to reject the Sharpe CAPM. Table 1 sets out a number of studies cited by the AER in rejecting the use of the Fama-French 3 factor model (FFM) to determine required returns on stocks.[8] The FFM links the expected return on stock to three factors: the beta of the stock, the equity value of stock (the size of the stock) and the book-to-market ratio of the stock.

22. Some of the papers cited by the AER are pure theory papers, while others are empirical studies of the relation between risk and return. Part A of Table 1 sets out the implications of the pure theory studies for the question of whether required returns are better-described by the Sharpe CAPM or the Black CAPM.

TABLE 1
Part A: Pure theory papers cited by the AER in rejecting the FFM

Paper cited by AER	
Ferson, Sarkissian and Simin (1999)	Theoretical result: The genesis for the theoretical examination in this paper is that the FFM provides a better empirical fit to the data than is provided by the Sharpe CAPM. Suppose that: i) Average returns are related to a stock's beta, size and book-to-market ratio (i.e., to the 3 factors of the FFM), and ii) Average returns are related to a stock's sensitivity to the market and to proxies for a 'size factor' and 'book-to-market factor' and hence can be given a risk-reward interpretation. Despite i) and ii) being true, it may be that the higher average returns empirically observed on small stocks and on stocks with

[8] The FFM is discussed in

Fama, Eugene F., and Kenneth R. French, 2004, "The capital asset pricing model: Theory and evidence," *Journal of Economic Perspectives* 18(3), pp. 25-46.

	high book-to-market ratios are the result of a behavioural bias of investors rather than a reward for risk. Empirical implication for the Black CAPM: The Black CAPM will be a better predictor of stock returns than is the Sharpe CAPM provided low beta stocks tend to be smaller stocks and/or tend to have higher book-to market ratios.
Lo and MacKinlay (1990)	Theoretical result: If properties of the data are known to those developing theories and if the resultant model is then tested on data that consciously or otherwise provided the genesis for the model, it can appear to be a better model than it subsequently proves to be. Empirical implication: The relative ranking of the FFM, Sharpe CAPM and Black CAPM when explaining past returns may not be their relative ranking in the future. There is *no* implication that the Sharpe CAPM will provide a better model of required returns than the FFM or the Black CAPM.
Roll (1977)	Theoretical result: i) For any efficient portfolio $Re = R0^E + \beta^E(R^E - R0^E)$, where $R0^E$ is the average return on any stock that has zero beta with respect to the return on that efficient portfolio, β^E is the beta of the stock measured with respect to the return on that efficient portfolio, and R^E is the average return on that efficient portfolio. A portfolio is an efficient portfolio if it is the portfolio with the minimum volatility within the set of all portfolios with a given level of expected return. ii) According to the Sharpe CAPM, the true market portfolio containing all bonds, stock and real estate is an efficient portfolio. iii) The stock market alone may not be an efficient portfolio. Empirical implication: Since the expected return on the stock market exceeds the expected return on the true market portfolio of all bonds, stock and real estate, then it is the case that even if the stock market is an efficient portfolio, the return on equity will be given by the Black CAPM and not by the Sharpe CAPM.
Roll and Ross (1994)	Theoretical result: The genesis for the theoretical examination is according to the paper's abstract that "empirical research has found little relation between sample mean returns and estimated betas." Thus the

	paper is motivated by the empirical observation that the relation between returns and betas is flatter than predicted by the Sharpe CAPM). The paper shows theoretically that such a near flat relation can arise even if the stock market is very close to an efficient portfolio. Empirical implication: The return on equity may be well-described by the Black CAPM even though it is not well-described by the Sharpe CAPM.

24. None of the four theoretical papers cited by the AER in rejecting the FFM provides any basis for a claim that the Sharpe CAPM theoretically dominates the FFM. Consider Ferson, Sarkissian and Simin (1999). That paper's theoretical explanation for the empirical superiority of the FFM over the Sharpe CAPM as potentially due to a behavioural bias by investors rather than a reward for risk does not challenge the empirical observation that gave rise to the paper—namely that the FFM provides a better empirical description of stock returns than the Sharpe CAPM does. Note also that all four theoretical papers cited by the AER in rejecting the FFM are consistent with the Black CAPM providing a better descriptor of average stock return than the Sharpe CAPM; in fact, the Roll and Ross (1994) analysis is motivated by exactly this empirical observation.

25. Part B of Table 1 sets out the results reported in those studies cited by the AER in rejecting the FFM that undertake an empirical examination of the link between risk and return. Part B of Table 1 also sets out the results in two classic tests of the Sharpe CAPM: Fama and Macbeth (1973) and Black, Jensen and Scholes (1972). Column 1 contains the author names and the year of publication of the study. Column 2 contains the sample period examined. Column 3 sets out the likelihood that the Sharpe CAPM is true given the data examined by the authors. Where it is possible to determine the ratio $\frac{Rm - R0}{Rm - Rf}$ from the results reported in the paper, column 4 reports the estimated value of this ratio. The notation n.a. denotes that this ratio could not be calculated from the results reported in the paper.

TABLE 1
Part B: Empirical papers cited by the AER in rejecting the FFM
plus 2 classic tests of the Sharpe CAPM

paper	Sample Period		$\frac{Rm-R0}{Rm-Rf}$
Empirical papers cited by the AER			
Schrimpf, Schröder and Stehle (2007)	1969 - 2002	Estimate of $Rm-R0=0.2\%$ per month. Note than an annual MRP of 6.5% implies a monthly MRP of 0.54% per month.	n.a.
Ang and Chen (2007)	1926 - 1963:06	Cannot reject the Sharpe CAPM	n.a.
	1963:07 - 2001	Likelihood the Sharpe CAPM true is $< 1\%$	n.a.
Gruaer and Janmaat (2010)	1963 - 2005	For 7 of the 14 methods for grouping stocks to form portfolios that are examined in the paper, the likelihood of the Sharpe CAPM being true is $< 5\%$	n.a.
Gregory and Michou (2009)	1975 - 2005	Examines 35 industries. For only 3 industries would one reject the Sharpe CAPM at the 5% level. For the *Gas, Water and Multi-utility Industry* returns are statistically significantly higher at the 5% level than predicted by the Sharpe CAPM	n.a.
Black (1993)	1926 - 1965	likelihood Sharpe CAPM true < 1%	n.a.
Schwert (2003)	1926 - 2001	likelihood Sharpe CAPM true < 0.0001%	n.a.
Morana (2009)	1965 - 2001	likelihood Sharpe CAPM true < 1%	n.a.
Daniel, Titman and Wei (2001)	1975 - 1997	likelihood Sharpe CAPM true < 0.34%	n.a.
Da, Guo and Jagannathan (2009)	1932 - 2007	likelihood Sharpe CAPM true < 0.002%	0.232
Kothari, Shanken and Sloan (1995)	1927 - 1990	likelihood Sharpe CAPM true < 0.058%	0.415
Classic tests of the Sharpe CAPM			
Fama and Macbeth (1973)	1935 - 1968	likelihood Sharpe CAPM true < 0.55%	0.639
Black, Jensen and Scholes (1972)	1931 - 1965	likelihood Sharpe CAPM true < 0.0001%	0.761
			Average = 0.511

26. Schrimpf, Schröder and Stehle (2007) do not test whether the Sharpe CAPM fits the data. Rather they conclude only that FFM does not fit the data better than the Sharpe CAPM does. For the first half of the sample period examined by Ang and Chen (2007) the authors do not reject the Sharpe CAPM. The authors do reject the Sharpe CAPM using data after 1963.

27. Although Gregory and Michou (2009) do not reject the Sharpe CAPM for most industries, the nature of their test bears discussion. Gregory and Michou regress the monthly return on an industry portfolio on the monthly return on the market. Most industries have betas near one and both the Sharpe CAPM and the Black CAPM make the same prediction for stock with a beta of one; the expected return on a beta one stock equals the expected return on the market. Gregory and Michou do not reject this prediction. Interestingly, for the portfolio whose beta is furthest from one, namely the *Gas, Water and Multi-utility Industry*, stock returns are significantly higher (at the 5% level) than predicted by the Sharpe CAPM. This is consistent with the true relation between expected returns and betas being flatter than the relation predicted by the Sharpe CAPM.

28. Every other study listed in Table 1B rejects the Sharpe CAPM and does so because the estimated return on a zero beta stock, R0, exceeds the risk-free rate, Rf. Equivalently, in every case the estimated difference in the return on the market and the return on zero beta stock is significantly less than Rm – Rf. Thus every other study documents that the thick line of Figure 1 is flatter than the thin line of Figure 1; i.e., that the empirical relation between the cost of equity and beta is flatter than is predicted by the Sharpe CAPM.

29. Where the paper's reported results make it possible to calculate the average values of (Rm – R0) and (Rm – Rf) over the sample period, the ratio of the two average differences is reported in column 4. Averaging over the four papers where this possible, the difference between the return on the market and the return on zero beta stock is only 0.511 of the difference predicted by the Sharpe CAPM.

30. The full citations for the set of papers in Table 1 are given below in the order the papers are listed in the table:

Ferson, Sarkissian and Simin, 1999, "The alpha factor asset pricing model: A parable," Journal of Financial Markets 2, pp. 49-68

Lo, Andrew W. and A. Craig MacKinlay, 1990, "Data-snooping biases in tests of financial asset pricing models," *Review of Financial Studies* 3(3), pp. 431-467.

Roll, Richard, 1977, "A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory," *Journal of Financial Economics* 4(2), pp. 129–176.

Roll, Richard and Stephen A. Ross, 1994, "On the cross-sectional relation between expected returns and betas," *Journal of Finance* 49(1), pp. 101-121.

Schrimpf, Andreas, Michael Schröder and Richard Stehle, 2007, "Cross-sectional tests of conditional asset pricing models: Evidence from the German stock market," *European Financial Management* 13(5), pp. 880–907.

Ang, Andrew and Joseph Chen, 2007, "CAPM over the long run: 1926–2001," *Journal of Empirical Finance* 14, pp. 1–40.

Grauer, Robert R. and Johannus A. Janmaat, 2010, "Cross-sectional tests of the CAPM and Fama–French three-factor model," *Journal of Banking & Finance* 34, pp. 457–470.

Gregory, Alan and Maria Michou, 2009, "Industry cost of equity capital: UK evidence," *Journal of Business Finance & Accounting* 36(5) & (6), pp. 679–704.

Black, Fischer, 1993, "Beta and return," *Journal of Portfolio Management*, 1993, 20(1), pp. 8–18.

Schwert,G. William, 2003, "Anomalies and market efficiency," in *Handbook of the Economics of Finance*, editors G. Constantinides, M. Harris and R. Stulz, Elsevier Science, ch. 15, pp. 937–972.

Morana, Claudio, 2009, "Realized betas and the cross-section of expected returns," *Applied Financial Economics*, 19, pp. 1371-138.

Daniel, Kent, Sheridan Titman and K.C. John Wei, 2001, "Explaining the cross-section of stock returns in Japan: factors or characteristics', *Journal of Finance*, 56(2), pp. 743–767

Da, Zhi, Re-Jin Guo and Ravi Jagannathan, 2009, "CAPM: Interpreting the evidence," NBER working paper 14889.

Kothari, S., Jay Shanken and Richard G. Sloan, 1995, "Another look at the cross-section of expected returns," *Journal of Finance*, 50(1), pp. 185–224;

Fama., Eugene F. and James D. Macbeth, 1973, "Risk, return, and equilibrium: Empirical tests," *Journal of Political Economy*, 81(3), pp. 607-636.

Black, Fischer, Michael C. Jensen and Myron S. Scholes, 1972 "The capital asset pricing model: Some empirical tests," in Studies in the Theory of capital Markets, Michael C. Jensen editor, (Praeger Publishers Inc.).

CONSISTENT ESTIMATION OF THE COST OF EQUITY GIVEN THE EMPIRICAL EVIDENCE

31. The empirical evidence that the Black CAPM provides a better fit to the data than the Sharpe CAPM is clear. What then is the bias in the Sharpe CAPM? The downward bias in the estimated cost of equity for low beta stocks will be greater the lower that beta is.

32. Consider a stock with a beta of 0.66. Assume that Rf is 4.9% and the MRP is 6.0%. The return on the market, Rm, is then Rf + MRP = 4.9% + 6.0% = 10.9%. The Sharpe CAPM would imply a cost of equity for our stock of

$$Rf + \beta(Rm - Rf) = 4.9\% + 0.66 \times 6.0\% = 8.86\%.$$

33. The Black CAPM provides a better fit to the data and the difference Rm – R0 can be approximated as $0.511\times(Rm - Rf)$ based on the average of the estimates of $\frac{Rm - R0}{Rm - Rf}$ in column 4 of Table 1B, and as 0.232 using the most recent estimate of $\frac{Rm - R0}{Rm - Rf}$ in Table 1B, namely that of Da, Guo and Jagannathan (2009).

34. Based on the average estimate of $\frac{Rm - R0}{Rm - Rf}$ in Table 1B, the empirically-based estimate of the cost of equity for a zero beta stock follows as

$$R0 = Rm - 0.511\,(Rm - Rf) = 10.9\% - 0.511(10.9\% - 4.9\%) = 7.83\%.$$

The empirically-based estimate of the cost of equity for a stock with a beta of 0.66 is then

$$R0 + \beta \times (Rm - R0) = 7.83\% + 0.66 \times (10.9\% - 7.83\%) = 9.86\%.$$

35. Based on the Da, Guo and Jagannathan estimate of $\frac{Rm - R0}{Rm - Rf}$, the empirically-based estimate of the cost of equity for a zero beta stock is

$$R0 = Rm - 0.232\,(Rm - Rf) = 10.9\% - 0.232(10.9\% - 4.9\%) = 9.51\%.$$

The empirically-based estimate of the cost of equity for a stock with a beta of 0.66 is then

$$R0 + \beta \times (Rm - R0) = 9.51\% + 0.66 \times (10.9\% - 9.51\%) = 10.43\%.$$

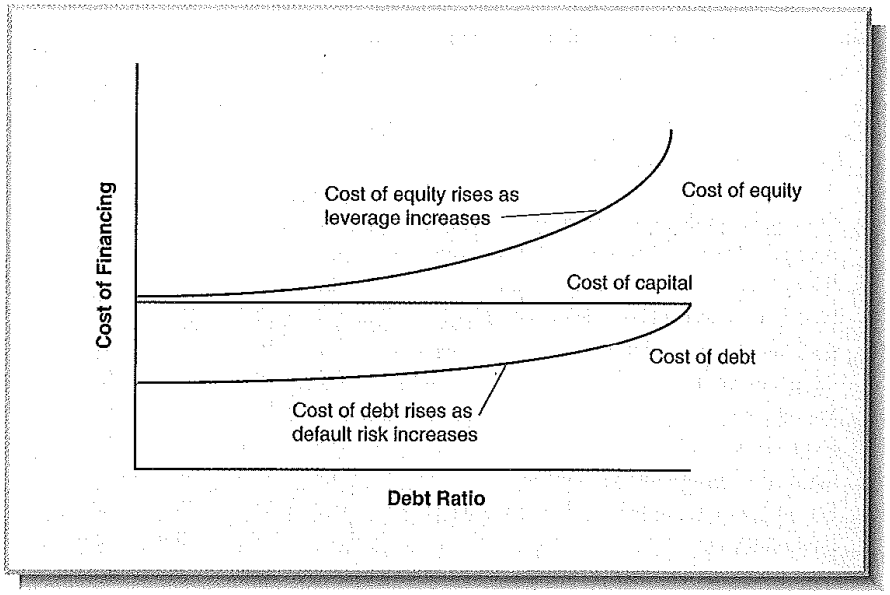
36. Thus the downward bias in a Sharpe CAPM-based estimate of the cost of equity for a

stock with a beta of 0.66 given the average estimate of $\frac{Rm - R0}{Rm - Rf}$ is then 9.86% – 8.86% = 1.00%. The downward bias in a Sharpe CAPM-based estimate of the cost of equity for a stock with a beta of 0.66 given the Da, Guo and Jagannathan estimate of $\frac{Rm - R0}{Rm - Rf}$ is 10.43% – 8.86% = 1.57%.

THE RELATION BETWEEN THE COST OF EQUITY AND THE COST OF DEBT

37. The relation between the cost of debt and a firm's leverage as measured by the the value of the firm's debt relative to value of the firm's assets, *D*/*V*, is convex. The Figure below (taken from the Damodaran (2001)[9] textbook) shows that the cost of debt initially increases very little as *D*/*V* grows from a very low level. But as the firm becomes increasingly debt-financed, the cost of debt becomes equal to the firm's cost of capital as the debtholders' claim on the firm comes increasingly closer to the right to 100% of the firm's cash-flows.

Figure 18.5 Cost of Capital in the Miller-Modigliani World



38. The convexity implies a lower bound on the Equity Risk Premium for a firm given the Debt Risk Premium. This follows from Miller-Modiglian proposition II which states that

[9] Damodaran, Aswath, 2001, *Corporate Finance: Theory and Practice*, 2nd ed, (John Wiley and Sons, Inc., NJ).

$$\text{Firm Risk Premium} = \frac{D}{V}\text{Debt Risk Premium} + \frac{E}{V}\text{Equity Risk Premium}. \qquad (4)$$

The convex relation between the Debt Risk Premium and D/V depicted in the Figure below implies immediately that the Debt Risk Premium must be less than $D/V \times$ Firm Risk premium. Substituting this inequality into (4) gives

$$\frac{D}{V}\text{Debt Risk Premium} + \frac{E}{V}\text{Equity Risk Premium} = \text{Firm Risk Premium} > \frac{V}{D}\text{Debt Risk Premium}.$$

39. For $D/V = 0.6$ this inequality is:

$$0.6 \times \text{Debt Risk Premium} + 0.4 \times \text{Equity Risk Premium} > \frac{1}{0.6}\text{Debt Risk Premium}.$$

rearranging this inequality gives the result that the Equity Risk Premium must be at least 2.66 times as large as the Debt Risk Premium. This relation provides a consistency check between the observed Debt Risk Premium for a firm and the minimum possible value for the Equity Risk Premium for that same firm if it finances with 60% debt.

40. A lower bound on the Equity Risk Premium also provides a lower bound on the cost of equity and hence a consistency check between the observed cost of debt and the cost of equity derived from an asset pricing model. If the firm has 60% debt financing and the asset pricing model does not imply an Equity Risk Premium at least 2.66 the observed Debt Risk Premium, then the asset pricing model is underestimating the true cost of equity for the firm

Bruce D. Grundy
Curriculum Vita

September 2010

Department of Finance, Faculty of Economics & Commerce

The University of Melbourne, Victoria 3010 AUSTRALIA

Education

PhD, Finance, Graduate School of Business, University of Chicago. 1992. Specialisations: Finance and Economics. Beta Gamma Sigma. Dissertation: "Preferreds and Taxes." Committee: Merton Miller (Chairman), George Constantinides, Douglas Diamond.

B. Com. Honours (1st Class), University of Queensland. 1977.

Academic Positions

Professor of Finance, University of Melbourne 2005-.

Ian Potter Professor, Melbourne Business School, 2000-2005.

Professor of Finance, University of Melbourne, 1998-1999.

Andrew Heyer Associate Professor of Finance, Wharton School, University of Pennsylvania, 1991-1998.

Assistant Professor of Finance, GSB, Stanford University, 1985-1990.

Visiting Positions:

Visiting Professor, Wharton School, University of Pennsylvania, 2005-2007.

Visiting Professor, Singapore Management University, Fall 2005.

Visiting Professor, University of Chicago, 2003

Metzler Bank Professor, Johann Wolfgang Goethe-Universität Frankfurt am Main 1998.

Visiting Professor, Macquarie University, 1994.

Publications

"Investor sentiment, executive compensation, and corporate investment," 2010, *Journal of Banking & Finance* 34, pp.2439-2449. Co-author: Michael Li

"Combining skill and capital: Alternate mechanisms for achieving an optimal fund size," forthcoming *Pacific Basin Finance Journal.*

"The analysis of VaR, deltas, and state prices: A new approach," forthcoming *Review of Finance*. Co-author: Zvi Wiener.

"Disclosure, hidden charges and indexed pensions," 2005, *Agenda: A Journal of Policy Analysis and Reform,* 12(1), pp. 33-46. Co-authors: Diana Beal and Sarath Delpachitra.

"Stock market volatility in a heterogeneous information economy," 2002, *Journal of Financial and Quantitative Analysis* 37(1), pp. 1-27. Co-author: Youngsoo Kim.

"Momentum: Fact or factor? Momentum investing when returns have a factor structure," 2001*, Review of Financial Studies* 14(1), pp. 29-78. Co-author: Spencer Martin.

"Merton H. Miller: His contribution to financial economics," 2001, *Journal of Finance* 56(4), pp. 1183-1206.

"Generalized properties of option prices," 1996, *Journal of Finance* 51(5), pp. 1573-1610. Co-authors: Yaacov Bergman and Zvi Wiener.

"Option prices and the underlying asset's return distribution," 1991, *Journal of Finance* 46(3), pp. 1045-1070.

"Changing risk, changing risk premiums, and dividend yield effects," 1990, *Journal of Business* 63(1), pp. 51-70. Co-authors: Nai-fu Chen and Robert F. Stambaugh.

"Optimal investment with stock repurchase and financing as signals," 1989, *Review of Financial Studies* 2(4), pp. 445-465. Co-author: George Constantinides.

"Trade and the revelation of information through prices and direct disclosure," 1989, *Review of Financial Studies* 2(4), pp. 495-526. Co-author: Maureen McNichols.

"Call and conversation of convertible corporate bonds: theory and evidence," 1986*, The Analysis of Security Prices* 31, pp. 35-70. Co-author: George Constaninides.

"The behavior of stock prices around ex-dividend dates," 1983, *The Analysis of Security Prices* 28, pp. 83-114.

Edited Volumes

Selected Works of Merton Miller: A Celebration of Markets. Vol I Finance, 2002 (University of Chicago Press, Chicago, Ill.

Selected Works of Merton Miller: A Celebration of Markets. Vol II Economics, 2002 (University of Chicago Press, Chicago, Ill).

Other Publications

"Stock return predictability in rational markets," 2007, *Insights: Melbourne Economics & Commerce* Volume 1 April.

"Real options analysis and investment appraisal: the opportunities and challenges," 2006, *Insights: Melbourne Economics & Commerce* Volume 4 November.

"Book Review: *Pricing and hedging of derivative securities* by Lars Tyge Nielsen," 2000, *Journal of Financial Research* 23, pp. 391-394.

Research papers:

"Optimal exercise and valuation of real options: The effects of uncertainty and asymmetric information," 2009, Co-author: Johannes Raaballe.

"Financing Strategies for Non-profit Organizations: Matching Grants or Seed Money," 2010, Co-author: Ning Gong.

"Do option markets undo restrictions on short sales? Evidence from the 2008 short-sale ban," 2010, Co-authors: Bryan Lim and Patrick Verwijmeren

"Convertibles and hedge funds as distributors of equity exposure," 2010, Co-authors Stephen J. Brown, Craig M. Lewis and Patrick Verwijmeren

"Coordinating Donations by Socially Conscious Employees: Employee Matching Grant Schemes vs. Lump-sum Donations," 2010, Co-author: Ning Gong.

Work-in-progress

"Expected returns and momentum for firms with low profitability and high investment," 2009, Co-authors: Gil Aharoni and Qi Zeng.

"Information and the term structure of expected future oil prices," 2009, Co-author: Richard Heaney.

"Differential information and derivatives pricing," 2009, Co-author: Qi-Zeng.

"Option prices, implied abnormal returns and momentum," Co-authors: Greg Clinch, John Lyon and Gary Twite.

"Valuing complex compensation packages," Co-author: Steve Usher

"A rational model of momentum and contrarian return behaviour," Co-authors Wei Li and Joe Zhang

"Characterizing multiplicative risk prudence in the presence of background risks," Co-author: George Wong.

"When can factor exposure 'explain' arbitrage profits," Co-author: Spencer Martin

"Corporate Social Responsibility and Corporate Donations," Co-author: Ning Gong

Awards

2010 Quantitative Finance/Risk Management/Derivative Instruments Finance, Corporate Governance Conference Prize

1998 Geewax-Terker Prize

1994-95 Batterymarch Fellowship

2008 FEC Teaching Award

2006 FEC Teaching Award

1994 Hauck Teaching Prize

1993 Outstanding Teaching Award (Wharton)

Grants

Australian Research Grants Council Discovery Grant, "Three Decades of Financial Distress and Corporate Restructuring in Australia" 2008-10, joint with Paul Kofman and Howard Chan. $104,537

Australian Research Grants Council Discovery Grant, "Storage and the Hotelling Valuation Principle: Understanding the Dynamics of the Oil Industry" 2007-09, joint with Richard Heaney. $345,000

National Science Foundation Grant, "Call and conversion of convertible bonds" 1985-1987, joint with George Constantinides, US$300,000

Professional Society Activities

Director: Asian Finance Association

Founding Member: Australian Financial Integrity Research Network

Fellow: Australian Society of Certified Practicing Accountants.

Member: Asian Finance Association, American Economics Association, American Finance Association, American Mathematical Society, European Finance Association, Western Finance Association.

Doctoral Colloquium Fellow: AFAANZ 2003 Colloquium, 2005 Colloquium.

Doctoral Consortium Fellow: AFAANZ 2004 Consortium

Doctorial Consortium Fellow: Asian Finance Association 2005

Doctorial Consortium Fellow: FMA Asia 2010
Australian Society of CPA's 1999 Research Lecture
FIRN Doctoral Tutorial Discussant: 2005-07.
FIRN Local Convener: 2006-present.

Managing Editor:

International Review of Finance, 2004-2008

Associate Editor:

Journal of Finance, 2000-2003
Journal of Financial Research, 1999-2006
Accounting and Finance, 1999-2002.
Journal of Financial and Quantitative Analysis, 1992-1996.
Review of Financial Studies, 1988-1994.
International Review of Finance, 2008-present

Editorial Board:

Accounting and Finance, 2002-present
Business Research, 2007-present
Insights: The Faculty of Economics & Commerce, 2007-present

Ad Hoc Referee:

Agenda
American Economic Review
Australian Journal of Management
Accounting and Finance
European Economic Review
European Journal of Finance
Financial Management
Financial Review
Journal of Accounting Research
Journal of Business
Journal of Business and Economic Statistics
Journal of Empirical Finance
Journal of Finance
Journal of Financial Economics

Journal of Financial Intermediation
Journal of Financial Services Research
Journal of Political Economy
Journal of Public Economics
Management Science
Mathematical Finance
Review of Accounting Studies
Review of Quantitative Finance and Accounting
Review of Financial Studies
Quarterly Journal of Economics

Program Committee:

Australasian Banking & Finance Conference: 2010.
American Economics Association Meetings: 1998.
American Finance Association Meetings: 2001.
Asian Finance Association Meetings: 2004, 2005, 2006, 2009.
Asian FMA Meetings, 2009, 2010
Finance Down Under Conference: 2009, 2010
European Finance Association Meetings: 2000, 2001, 2002, 2005, 2010.
European Financial Management Association Meetings: 1999.
Indiana University Symposium on Design of Securities and Markets: 1993.
Journal of Accounting Research Annual Conference: 2002-03.
Western Finance Association Meetings: 1990-91, 1994-95, 1997-98, 2004, 2007-10.
Review of Accounting Studies Annual Conference: 2004, 2005.
Singapore International Conference on Finance: 2008, 2009, 2010.
Society for Financial Econometrics: 2010

Reviewer:

Chair External Review Committee, ANU School of Business Department of Finance, Applied Statistics & Actuarial Science: 2010
Research Grants Council of Hong Kong: 1997, 2000, 2004, 2005, 2008, 2009.
National Science Foundation Proposals: 1990, 1991, 1994 and 1997.
Australian Research Council: 1994, 1995 and 2007.
Social Sciences and Humanities Research Council of Canada: 1993 and 1994.
Australian Accounting Research Foundation Exposure Draft on Director and Executive Disclosures.
Singapore Management University Quantitative Finance Programmes
External Reviewer, Accounting & Finance Department, Monash University: 2002

Discussant:

Accounting & Finance Association of Australia and New Zealand Meetings: 2006, 2007

American Finance Association Meetings: 1986-900, 1994-95, 2006.
Annual Conference on Financial Economics and Accounting: 1992 and 1996.
ANU Summer Camp: 2008, 2009.
Asia-Pacific Finance Association Meetings: 1999.
Asian Finance Association Meetings: 2004, 2005, 2006, 2009.
Asian FMA Meetings: 2010.
European Finance Association Meetings: 1995, 2002, 2005, 2010.
Fifth Annual Texas Finance Festival: 2003.
FIRN Research Day: 2010
Paul Woolley Centre on Capital Market Dysfunctionality Conference: 2008, 2009
Simulation Based & Finite Sample Inference in Finance Conference: 2003.
Singapore International Conference on Finance: 2008, 2009
Western Finance Association Meetings: 1993 and 1997.

Session Chair:

Accounting & Finance Association of Australia and New Zealand Meetings: 2003-05.
Asian Finance Association Meetings: 2004, 2005, 2006, 2009.
Asian FMA Meetings: 2010.
Australasian Finance & Banking Conference: 2003.
American Finance Association Meetings: 2001.
European Finance Association Meetings: 2002, 2005, 2010.
Western Finance Association Meetings: 1995.

Keynote Speaker:

Accounting & Finance Association of Australia and New Zealand Meetings: 2003.
Australasian Banking & Finance Conference: 2002.
Asian FMA Meetings: 2010.

Organizer:

The Dollars and Sense of Bank Consolidation: MBS Conference 2002.
Risk Management and Pricing for Financial Institutions: Lessons from the Closed-End Fund Industry: Wharton Financial Institutions Centre Conference 1995.
Finance Down Under Conference: 2007, 2008, 2010.

Conference Presentations:

Australian Conference of Economists: 2006.
Asian Finance Association Meetings: 2004, 2005 and 2006.
Asian FMA Meetings: 2010.
Australasian Q-group: 1999, 2004.
HKUST Annual Finance Symposium: 2004.
Third National Symposium on Financial Mathematics: 2004.

AGSM Finance and Accounting Camp: 1996, 1997 and 1999.

American Finance Association Meetings: 1986, 1989, 1990, 1996, 1997 and 1998.

NBER Summer Institute: 1998.

Annual Conference in Financial Economics and Accounting: 1995 and 1996.

American Mathematical Society Meetings: 1996.

European Finance Association Meetings: 1995, 2002, 2005, 2010.

NBER Financial Risk Assessment and Management Conference: 1995.

N.J.C.R.F.S. Conference in Security Design and Innovations in Financing: 1993.

Western Finance Association Meetings: 1984, 1989, 1993, 2010.

Sixth Annual Conference MSMESB: 1991.

Australasian Banking and Finance Conference: 1989 and 2007.

ZEW Centre for European Economic Research, Mannheim: Conference on the Economics of Charitable Fundraising: 2009

Seminar Presentations:

Australian Graduate School of Management

Australian National University

Bond University

Boston College

Carnegie-Mellon University

Central Queensland University

Chinese University of Hong Kong

Columbia University

Commodity Futures Trading Commission

Cornell University

Dartmouth College

Duke University

Fields Institute for Research in Mathematical Sciences

Hong Kong University of Science and Technology

Humboldt University

Indian School of Business

Insead

London Business School

London School of Economics

Macquarie University

Massey University

Melbourne Business School

MIT

Monash University
National University of Singapore
New York University
Northwestern University
NUS Risk Management Institute
Odense University
Ohio State University
Queen's University
Queensland University of Technology
Singapore Management University
Stanford University
The State University of New Jersey, Rutgers
University of Aarhus
University of Adelaide
University of Alberta
University of British Columbia
University of California Berkley
University of California Irvine
University of California Los Angeles
University of Chicago
University of Frankfurt am Main
University of Houston
University of Illinois Champaign,
University of Oregon
University of Maryland
University of Melbourne
University of Michigan
University of Minnesota
University of New South Wales
University of North Carolina Chapel Hill
University of Queensland
University of Sydney
University of Technology Sydney
University of Vienna
University of Western Australia
University of Washington in St Louis
Vanderbilt University
Victoria University Wellington
Washington University

Yale University

Manuscript Reviewer:

University of Chicago Press
Cambridge University Press
Academic Press.

Teaching Experience

Derivatives-related courses: Honours, Masters and PhD courses on options, futures, swaps, mortgage-backed securities and exotics.

Corporate Finance-related courses: Honours, Masters and PhD courses on capital budgeting, mergers and acquisitions, corporate taxation, agency problems, information asymmetries, and security design.

Corporate Governance: MBA course

Real Options and Resource Projects: Undergraduate and MBA courses

Financial Management: Executive MBA course

Executive Education:

ABN Amro, Australian Graduate School of Management, KPMG, Liechtenstein Global Trust, Melbourne Business School, PaperLinx, PWC, Susquehanna Investment Group, Telstra Risk Management and Assurance, Turkish Capital Markets Board, Wharton School Pension Funds and Money Management Program

Member of Thesis Committees:

Completed (first appointment): Mahmoud Agha (University of Western Australia), Ken Bechmann (Copenhagen Business School), Jacob Boudoukh (New York University), Jennifer Carpenter (New York University), Adam Dunsby (Goldman Sachs), Michael Gallmeyer (Carnegie-Mellon), Pekka Heitala (Insead), Terry Hildebrand (Enron), Ron Kaniel (University of Texas), Youngsoo Kim (Alberta), Michele Kreisler (Morgan Stanley), Guan Hua Lim (University of Singapore), Hui Li (Deakin) Spencer Martin (Ohio State), Krishnan Maheswaran (Melbourne University), Ed Nelling (Georgia State), Ian O'Connor (Melbourne University), Rob Reider (J.P Morgan), Mark Vargus (University of Michigan).

In Progress: : Zhenhua Liu, Alya Al Foori, Yangyang Chen, Chelsea Yao, George Wang

External PhD Examiner:

Aarhus University
University of Technology Sydney
University of Sydney
University of Western Australia
University of New South Wales

Administrative Positions

University of Melbourne

Cost Containment Committee: 2007.
Business@Melbourne Coordinating Committee: 2007-2008.
Melbourne Business School Committee: 2006-present
Academic Structures Working Group: 2008-2009.

University of Melbourne, Faculty of Business & Economics:

Deputy Dean: 2006-2007.
FEC Advisory Board: 2007-2008.
Convener Melbourne Derivatives Research Group: 2006-present.
Finance Seminar Convener: 2007-2009.
FIRN Local Coordinator: 2006-present.
PhD Coordinator, Department of Finance: 2007, 2009-present.
Accounting and Finance Department Committee: 1999.
Research and Research Training Committee: 1999, 2007, 2009-present.
International Committee: 2009.
SSPL Committee: 2009.
Academic Promotions Committee: 2009-present.
Head, Department of Finance: 2010-present.

University of Melbourne, Melbourne Business School:

Director Ian Potter Centre for Financial Studies: 2000-2005
Academic Planning and Development Committee: 2002-2005.
Curriculum Committee: 2002-2005.
Seminar Convener: 2000-2005.

The Wharton School:

Convenor Corporate Finance Workshop: 1995-1997.
Wharton Fellows Fund Oversight Committee: 1993-1997.
Recruiting Committee: 1995-1996.
Finance Seminar Convener: 1992-1994.

Stanford Graduate School of Business:

Finance Seminar Convener: 1988-1990.
Deans Advisory Committee: 1986-1988.