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An investigation of the equity premium using habit utility and equity returns: Australian evidence

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The Use of Thesis statement is not included in this version of the thesis.

Abstract

The gap between the return on stocks and the return on the risk free assets represented by bonds is named the 'Equity Premium' or 'Equity Risk Premium'. In the history of asset pricing models, one of the most serious problems for the equity premium is that the average equity premium is too large to be explained by standard general equilibrium asset pricing models. Researcher's have tried to use variables such as dividend yield's to explain the gap between stocks and bonds with mixed results. After retrieving around a one percent equity premium with the most standard consumption base asset pricing models or Lucas styled asset pricing model, Mehra and Prescott (1985) first recognised this problem and announced it as a 'Puzzle'. In their analysis they used Lucas's (1978) standard asset pricing model where a representative investor has additive and separable utility functions in the perfect market. Compared to other forms or utility functions, at a certain period, these conventional preferences derived from utility of consumption in previous periods. Also this utility maintains a constance risk averison parameter, γ, over the reasonable consumption boundaries.

In this study two approaches are adopted. The first involves the commonly applied dividend yield approach to forecasting the equity premium. The results obtained from using the current and lagged divided yield to try to capture the size and movement in the market risk premium are shown in chapter three. The results are not particularly promising.

The remainder of the dissertation is devoted to a more sophisticated model: the consumption capital asset pricing model with habit derived by Campbell and Cochrane (1995) is tested using Australian data. The utility specification separates the temporal choice from state contingent choice and in doing so resolves part of the equity premium puzzle. The model is able to generate an equity premium using consumption data that is collinear with the actual premium, but with a significantly different volatility. The conclusion is that the state and time separable model is only partly able to resolve Mehra and Prescott's (1985) equity premium puzzle.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

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Chapter 1

General Introduction

The equity risk premium is measured as the extra return that equity holders expect to achieve over risk-free assets on average. In the traditional Capital Asset Pricing Model, the risk premium is the additional return required in compensating investors for one unit of (beta) risk. On in other words, the risk premium measures the "extra return" that would be demanded by investors for shifting their money from a riskless environment to an average risky investment.

In order to understand the market wide premium we first have to understand the mechanics and intuitions behind the Capital Asset Pricing Model (CAPM). Prior to the path-breaking work of Markowitz (1952), the risk of investments involved, for example, in the purchase of the stocks of a start-up biotechnology company were evaluated on a stand-alone basis. Because drug research projects have a huge dispersion of possible outcomes, from outright failure to billion-dollar bonanzas, the purchase of the stock of a one-drug biotechnology company is extraordinarily risky when considered in isolation. The insight of Markowitz was that there is no need to hold such an investment on a stand-alone basis. In the same fashion that insurance companies diversify risks by writing a large number of policies, investors can diversify risks by holding a large number of securities. Therefore, when considering an individual security, investors will ask how much risk this individual security adds to a diversified portfolio. Markowitz showed that if investors hold well-diversified porfolios, as they do to minimise bearing unnecessary risk, then the risk of individual securities depends more on the correlation of those possible outcomes with the return on the market porfolio than on the dispersion of individual outcomes.

A direct offshoot of Markowitz's work was the articulation of the distinction between systematic and nonsystematic risks. To understand the difference between systematic and nonsystematic risk, consider a hypothetical investment in Apple Computer. The risks associated with this investment can be seen as arising form two sources. First, there are risks that are unique to Apple. Will Apple design competitive products? Will computer users accept Apple's new operating system? Second, there are risks that affect all common stocks. Will the economy enter a recession? Will war break out in the Middle East?

Those risks that are unique to Apple can be eliminated by diversification. An investor who invests only in Apple will suffer significant losses if Apple's new products area suffers failure, but an investor who holds Apple along with hundreds of other securities will hardly notice the impact on the value of his or her portfolio if Apple's new products fail. Therefore, risks that are unique to Apple are said to be nonsystematic or diversifiable.

On the other hand, market wide risks cannot be eliminated by diversification. If the economy enters a recession and stock prices fall across the board, investors holding hundred's of securities are no better off than investors who put all their money in Apple Computer. Thus, economy wide risks are systematic and nondiversifiable.

Building on Markowitz's insights, Sharpe (1964) and Lintner (1965) deveoped a specific risk measure, beta, that took account of the distinction between systematic and nonsystematic risk. They showed that the market would pay a risk premium only for those risks that could not be eliminated by diversification. The explicit mathematical relation they derived is the now-famous capital asset pricing model (CAPM), as show in Equation 1.1.

$$[E(R_s)] - R_f = (\text{the Security's Beta}) \bullet [\mathrm{E}(\mathrm{R}_m) - R_f] \qquad (1.1)$$

The CAPM states that the risk premium for a security – which by definition equals the expected return on the security, $E(R_s)$, minus the risk free rate, R_f – is equal to the security's beta times the market risk premium.

From Equation 1.1 it is clear that the CAPM is a relative asset pricing model. It tells not what the risk premium is for an individual security but what the security's risk premium is relative to the market portfolio. If a security's beta is 1.0, meaning that its nondiversifiable risk is the same as that of the market, then its risk premium equals that of the market porfolio. More generally, the risk premium for an individual security is proportional to the risk premium on the market with a proportionality constant equal to beta.

The CAPM and most well-known asset pricing models give the risk premium of individual assets in terms of the market risk premium, they do not offer assessment of the market risk premium itself. That requires a more basic model that relates risk to the ultimate source of benefit provided by investment – future consumption. At a fundamental level, what any investment does is move consumption forward in time. Stated differently, investing means foregoing consumption today in order to have the opportunity to consume more tomorrow. So in this study we focus on the risk premium as an excess return on the market porfolio rather than the risk premium associated with individual stocks. Investors are generally inclined to invest in a risky environment in addtion to risk free assets and therefore its important to access the market wide return (which is the market index) and the return on a broad category of risk free assets. The risk free assets are generally proxied by short term and long term bonds and the treasury bill rate.

We must also observe the importance of the equity premium in corporate decision (investment) making. Big corporations tend to have investments in a basket of companies and it is crucial that they observe the excess market return over risk free assets as returns generated from these basket of equities play a significant role in shareholder returns. Companies like AMP, the four major banks (National Australia Bank, Commonwealth Bank, ANZ and Westpac) are in the top 10 investors in many small to medium publicly listed companies.

Finance theory also teaches us that a company should undertake all projects that have a positive net present value. The calculation of present value depends on the firm's opportunity cost of capital, which serves as the discount rate. The opportunity cost of capital, in turn, is greatly influenced by the cost of equity. Modern Asset pricing models such the capital assest pricing model (CAPM), employs a two step procedure for estimating the cost of equity. First, the cost of equity is estimated for the market as whole. Because cost of equity for the market is a synonym for expected return on the market, that is determined by a forecast of the equity risk premium.

Second, the market wide cost of equity is adjusted to take account of the risk of the company's equity relative to the risk of stocks generally. Although deciding how the adjustment should be made has been the focus of a great deal of attention in the finance literature, the expected return on the market is perhaps an even more important determinant of the discount rate. In this fashion, the equity risk premium determines in part what investment projects are undertaken in the economy.

The basic understanding of the equity premium is that it is the spread between equities and bonds. Despite numerous attempts to estimate the value of this premium, there is some debate as to which of the many empirical estimates represents the true premium required by equity investors. The importance the equity premium has also been emphasised by big property companies such as Centro who attract many high profile investors and form syndicates which are than used to purchase shopping centres around Australia and New Zealand. If the spread between the stock market and risk free assets increases as a result of improvements in the stock market, than the property companies have to think twice about starting up shopping centre syndicates. An increase in the stock market shows that investors are willing to take on more risk and high profile investors are likely to move away from less risky property syndicates. Contrary to this, if the risk pemium is falling than investors will shy away from the stock market and some will enter the property syndicates and also move towards bond and treasury style risk free assets. The syndicates basically guarantee some fixed quarterly income to the participants (depending on the stability of rental income) and the risk level is therefore somewhere between that of listed equities and bonds. .

While it is well known that over the longer-term, equity outperforms Treasury bills, the enormous magnitude of this out-performance is less well known. Ibbotson and Associates, the "gold-standard" provider of historical equity premium data, show that an investment of $1 in 1925 would be worth $5,116 by 1998, whereas an investment in treasury bills would only be worth $15 (Tufano, 2000). Between 1900 and 1998 the simple geometric mean equity premium for New York Stock Exchange (NYSE) value-weighted stocks was 6.07% pa, utilizing the government (Treasury) bill rate as a proxy for the 'riskless' rate.[1] In a celebrated paper Mehra and Prescott (1985) attempt to account for this premium using simulations derived from an equilibrium model of intertemporal optimisation by a representative investor who consumes aggregate consumption, which abstracts from transaction costs and security market trading, liquidity considerations and other frictions. As Campbell (1999) points out, the risk premium depends on the product of the coefficient of relative risk aversion and the covariance between the return on the asset and growth rate of consumption. But the growth rate of consumption in the US has empirically been very smooth. Mehra and Prescott are able to account for only a negligible proportion of this premium with a maximum of 0.4% explained by risk aversion. Only if the degree of risk aversion were implausibly high would their simulations be able to explain the observed premium. A high degree of risk aversion would also create other problems.

[1] I update NYSE data used by Fisher (1995) which in turn is based on Schwert (1990). Bill Schwert also provided additional data from his website.

As investors become more risk averse, they should demand a larger premium for shifting from the riskless asset. While some of this risk aversion may be inborn, some of it is also a function of economic prosperity (where the economy is doing well, investors tend to be much more willing to take risk) and recent experiences in the market (risk premiums tend to surge after large market drops).

As the riskiness of the average risk investment increases, so should the equity premium. This will depend upon what firms are actually trading for in the market, their economic fundamentals and how good they are at managing risk. For instance, the premium should be lower in markets where only the largest and most stable firms trade. This is because large stable (or some call them value stocks) will have a lower risk associated to them and this in turn will reduce the overall market return therefore causing a decline in the equity premium. For example, if researchers used the Dow Jones index to calculate the equity premium, then most of the Dow 30 stocks are considered as stable, resulting in much smaller equity premium. Since this is the case, most papers using U.S. data focus on the S&P 500 index as it gives a much broader representation of the market index composition in estimating equity premiums.

This study looks at the behaviour of the equity premium in the Australian market. It commences using forecasting methodology for estimating the market risk premium in Australia by means of employment of an in-sample and out-of-sample forecast estimate using various dividend yield measures. The lagged dividend yield model is used to predict future equity premia on a data series that includes the top 85 percent of the Australian stock market. An important concern is the accuracy of dividend yields in forecasting the equity premium in the Australian market. The results sugggest that the level of predictability in the later part of the series is very weak compared to in-sample prediction during the 70s and 80s. This finding is similar to many claims in most U.S. studies that find that other macroeconomic factors such as the business cycle, inflation and the level of economic growth can play a part in the prediction process.

An alternative approach is therefore adopted. I compare the size (average) and ability to forecast the equity premium by deriving the consumption capital asset pricing model (CCAPM) and Constant Relative Risk Aversion (CRRA) using habit utility and risk aversion theory. The CCAPM is basically an extension of the standard asset pricing model. Macro and financial economists have naturally been attracted to the CCAPM since it is the first-order condition of a well-specified intertemporal optimisation problem for households. Furthermore, it solves two problems with the CAPM. First, the central variable in CAPM, the return on the market portfolio of risky assets, is difficult to measure directly since investors have large holdings of non-traded assets such as human capital. In CCAPM, the growth rate of consumption is a perfect measure of that return. Second, unlike CAPM, CCAPM fully accounts for the intertemporal nature of portfolio choices. The CAPM basically restricts the market wide portfolio to assets alone rather than looking at other classes of assets.

The CRRA utility function was introduced by (see Romer (2001, pp. 48) is given by equation (1.2).

$$
\begin{aligned}
U(C) &= \frac{C^{1-\gamma}}{1-\gamma} \text{ for } \gamma > 0,\ \gamma \neq 1, \qquad (1.2)\\
&= \ln C \quad \text{for } \gamma = 1
\end{aligned}
$$

Where $1/\gamma$ is the intertemporal substitution elasticity between consumption in any two periods, i.e., it measures the willingness to substitute consumption between different periods. The smaller γ (the larger $1/\gamma$), the more willing is the household to substitute consumption over time. Note also that γ is the coefficient of relative risk aversion. Since the coefficient of relative risk aversion is constant, this uitlity function is known as constant relative risk aversion (CRRA) utility.

There are three other properties that are important. First, the CRRA utility function is increasing in $C^{1-\gamma}$ if $\gamma < 1$ but decreasing if $\gamma > 1$. Therefore, dividing by 1 - γ ensures that the marginal utility is positive for all values of γ. Second, if $\gamma \to 1$, the utility function converges to $\ln C_t$. Thirdly, the third derivative, $U'''(C) > 0$, thus implying a positive motive for precautionary saving. Therefore, we often use this utility function when studying consumption and savings behaviour. Since our topic will be embarking on the issue of how habit utility and how consumption habit influence the risk averseness of investors, its is appropriate to assign such utility's.

We also compare our estimates of a GARCH model previously utilised in the only study of the Australian equity premium by Heaney and Bellamy (1997). Volatility is a central part of most asset pricing models. In these models, one often assumes that the volatility is constant over time. However it is well know financial time series exhibit time-varying volatility. In 1982 Engle proposed a model for the standard deviation of returns.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i X_{t-i}^2 \qquad (1.3)$$

This model is called the Autoregressive Conditional Hetroskedasticity (ARCH process) where the "autoregressive" property in principle means that old events leave waves behind a certain time after the actual time of the action. The process depends on its past. The terms "conditional hetroskedasticity" means that the variance (conditional on the available information) varies and depends on old values of the process. One can view this as being consistent with the process having a short-term memory and the fact that the behaviour of the process is influenced by this memory.

However, since it can be expected that σ_t^2 is a time-changing weighted average of past squared observations, it is quite natural to define σ_t^2, not only as a weighted average of past X_t^2's, but also of past σ_t^2. Empirical evidence has shown that a high ARCH order has to be selected in order to catch the dynamic of the conditional variance. The high ARCH order implies that many parameters have to be estimated and the calculations get burdensome. As a result this leads to the Generalised ARCH model (GARCH) introduced in 1986 by Bollerslev. This model is based on the infinite ARCH specification and it allows for the dramatic reduction of the number of estimated parameters from an infinite number to just a few. In the GARCH model the conditional variance is a linear function of past squared innovations and earlier calculated conditional variances.

The volatility process is:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i X_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2, \qquad (1.4)$$

where α_i's and the β_j's are non-negative parameters.

Financial time series often exhibit some well-known characteristics. First, large changes tend to be followed by large changes and small changes tend to be followed by small changes. Secondly, financial time series often exhibit leptokurtosis, which means that the distributions of their returns are fat-tailed (i.e. high probability for extreme values).

The GARCH model successfully captures the first property described above, but sometimes fails to capture the fat-tail property of financial data. This has led to the use of non-normal distributions to better model the fat-tailed characteristic. We do not encounter this problem in our data and find that a GARCH (1,1) model fits nicely.

GARCH has gained fast acceptance and popularity in the financial world. This can be explained by various arguments: firstly the GARCH process has a close relation to ARMA process. This suggests that the theory behind the GARCH process might be closely related to the theory of ARMA process, which is well studied and widely known. Secondly, one can get a reasonable fit to real life financial data even with a GARCH (1,1) with only three parameters, provided that the sample is not too long so that the stationary assumption is unreliable.

By using these various techniques we can see whether the notion that the equity premium is too high in the U.S., also applies to the Australian market or whether it is unique to the U.S. market. We compare the equity premium on a market wide index to see if there exists some explanation for the equity premium puzzle. This study also investigates the behaviour of the equity premium in boom and bust cycles. We also observe the movement of the equity premium when different measures of risk-free rates are used namely, short and long term government securities.

The study uses the Australian All Ordinaries value weighted index and the Datastream[2]™ value weighted index (which includes only the top 80% of market capitalisation) to see if this value-weighted index captures the entire market risk premium. We use this index as the data spans from January 1973 for the crucial variables used in our modelling.

[2] Datastream is a data service provided by Thomson Financial. Datastream measures its own index values for various stock exchanges. We have used this series due to longer data coverage, which is very important in capturing the premium cycles.

Purpose of the Study

The purpose of this study is to analyse the Australian equity premium and in particular to study whether the premium is predictable. There are three ways of estimating the risk premium in the capital asset pricing model – large investors can be surveyed about their expectations for the future, the actually premium earned over a past period can be obtained from historical data, and the implied premium can be extracted from current markets data. The premium can be generally estimated only from historical data in the arbitrage pricing model and the multifactor models. Give these many approaches in addressing the equity premium issue, we concentrate on explaining the theories of Mehra and Prescott (1985) and Campbell and Cochrane (1995) who use the concept of risk aversion to explain the equity premium puzzle.

Following Roll's (1977) critique of the capital asset pricing model (CAPM) there was a search for alternative asset pricing models. One model which gained popularity was the consumption based capital asset pricing model (CCAPM) which was favoured because it was easily extendable to multiple periods and included endogenised returns. The static asset pricing model like CAPM ignores the simultaneous consumption decision and saving over time. So CAPM treats asset prices as being determined by the portfolio choices of investors who have preferences defined over wealth one period in the future. Implicitly, these CAPM styled models assume that investors consume all their wealth after one period. This simplification is quite unsatisfactory to economies because they believe consumption and asset prices are interrelated and determined in the market at the same time. Also in the CAPM styled models, the risk free return asset is given or exogenous to the model. However in the financial market, these two assets' prices are determined at the same time. Therefore to explain either equity or bond prices, we have to internalise the pricing of the bonds.

On the other hand, the Lucas styled asset pricing model includes consumption and portfolio decisions in the same model. The Lucas asset pricing model or Consumption Capital Asset Pricing Model (CCAPM) and the Kreps and Porteus (1978) and Lucas (1978) are credited with its early development using constant relative risk aversion (CRRA) expected utility functions. However, Mehra and Prescott (1985) showed that this version of the CCAPM was unable to account for the larger U.S. equity premium with reasonable levels of risk aversion. Engsted (1998) found the equity premium puzzle also exists in the Danish, German, Swedish and U.K. economies. The puzzle presented a problem to researchers because of its ramifications for rational expectations and market efficiency. It implied that either investors are irrationally risk averse or they are not forward looking. A third possibility, supposing investors do not have a reasonable risk aversion, is that the market is inefficient and does properly price risk aversion. Several authors (including Epstein and Zin 1989, Abel 1990, Constantinides 1990, Campbell and Cochrane 1995) tried to resolve the puzzle by respecifying the CCAMP using habit utility. None of these authors were able to prove conclusively the existence of habit, and all used U.S. data. This study contributes to the habit literature by testing one form of habit specification with Australian data.

The first part of this study tests the model specified in Campbell and Cochrane's (1995) NBER working paper. They find that their model can predict an equity premium series that is correlated with the actual premium, but is insufficiently volatile.

In contrast to using habit type models we can also do some more rigorous empirical tests based on the pionering work of Fama and French (1991) that assest returns are predictable. The levels of predictability of stock returns are only predictable if we expect the dividend yield over the entire sample to be mean reverting. We use various forms of the dividend yield ratio to try and test whether dividend yields are good enough in forecasting the equity premium. We employ the standard forecasting tests ie., Root Mean Squared Error (RMSE) and MAPE (Mean Abosolute Percentage Error). We also test the model using generalised impluse response functions[3], i.e., by shocking the standard deviation of each individual variable by 1 unit and observing the resulting effects of these shocks on other variables.

[3] Generalised Impulse Response Function are discussed in Chapter 2.

Plan of the Study

The remainder of the study is as follows: Chapter 2 provides a literature review on the equity premium and the various studies done in forecasting it. Chapter 3 presents the methodology and results of using the dividend yield to estimate the equity premium. Although it is not customary in a dissertatioin to report results early, we do so in this chapter as the methodology of using dividend yields varies greatly in comparison to the rest of the dissertation. Chapter 4 reviews the CCAPM and the shortcomings of using CRRA utility. This includes a presentation of the study of the equity premium puzzle in depth. In Chapter 5, Campbell and Cochrane's habit formation model is derived fully in the context of estimating the habit model. Chapter 6 discusses the econometric tests and methods that are employed in the course of empirical estimation and analysis. We discuss the habit models in details and the mathematics underlying these models. In this section we also present the testing phase for the dividend yield models. Chapter 7 discusses the results from the CCAPM and Habit models and how these models can explain the equity premium based on cosumption patterns. We conclude in Chapter 8 by drawing some key implications from our results and make suggestions for further research.

Chapter 2

Forecasting the Equity Premium Using the Dividend Yield Approach

This chapter provides a forecasting methodology for estimating the market risk premium in Australia. We employ an in-sample and out-of-sample forecast estimate using various dividend yield measures. The lagged dividend yield model is used to predict future equity premia on a data series that includes the top 85 percent of companies by value in the Australian stock market. An important concern in this paper is the accuracy of dividend yield in forecasting the equity premium in the Australian market. We find that the level of predictability in the later part of the series is very weak compared to in-sample prediction during the 70s and 80s. This finding is similar to many previous findings in many U.S. studies which report that other macroeconomic factors such as the business cycle, inflation and the level of economic growth can play a part in the prediction process.

While there are many topics in the area of finance upon which academics agree, a topic as basic as the equity risk premium still can produce some vigorous debate. Equity risk premiums are a central component of every risk and return model in finance. The concept of equity risk premium is important to an investor as he or she makes an investment decision. The equity risk premium is the reward that investors require, when accepting the uncertain outcomes associated with owning equity securities.

The most common approach to estimating equity risk premiums remains the use of historical returns, with the difference in annual returns on stocks and bonds over a long time comprising the expected risk premium, in the future. Brealey and Myers (1991) cover wide-ranging problems with beta estimates in the CAPM, but without further discussion, simply use the long-run historic average annual risk premium of 8.4 percent to calculate the expected return. There are limitations to this approach given that the attitude to holding assets has changed over time. In the history of the asset pricing model, one of the more serious problems for the equity premium is that the average equity premium in the long run is too large to be explained by standard general equilibrium asset pricing models. After retrieving around one percent equity premium with the most standard consumption base asset pricing model or Lucas styled asset pricing model, Mehra and Prescott (1985) first recognised this problem and announced it as a 'Puzzle'. It arises from the observation that the average real return on equity over the last the last century in the USA has been about 7% while the average rate of return on riskless, short term securities has been about 1%. According to Ibbotson Associates, stocks have returned 11 percent a year since 1926, compounded annually, and bonds have returned 5 percent. Accordingly, the historical equity risk premium is around six percent.

Mehra and Prescott (1985) argue that the historical level of the ex post US equity premium (over the post 1926 period) is puzzlingly high. In their model, individuals were assumed to have additively separably utility functions and constant relative risk aversion. The relevant parameter in their model is the coefficient of relative risk aversion: 'A', a parameter whose interpretation is such that if consumption falls by 1 per cent, then the marginal value of a dollar of income increases by A per cent. In their model Mehra and Prescott found that to explain historic equity risk premium, A needed to be between thirty and forty (percent), which was deemed to be much too high[4].

The notion that risk matters, and that riskier investments require a higher expected return than safer investments, to be considered good investments, is intuitive. Thus, the expected return on any investment can be written as the sum of the riskfree rate and an extra return to compensate for the risk. The disagreement, in both theoretical and practical terms, remains on how to measure this risk, and how to convert the risk measure into an expected return that compensates for the risk.

Risk and Return Models

While there are several competing risk and return models in finance, they all share some common views about risk. First, they all define risk in terms of the variance of actual returns around an expected return; thus, an investment is riskless when actual returns are always equal to the expected return. Second, they all argue that risk has to be measured from the perspective of the marginal investor in an asset, and that this marginal investor is well diversified. Therefore, the argument goes, it is only the risk that an investment adds on to a diversified portfolio that should be measured and compensated.

In fact, it is this view of risk that leads risk models to break the risk in any investment into two components. There is a firm-specific component that measures risk that relates only to that investment or to a few investments like it, and a market component that

[4] To see why this is so, consider a gamble where there is a 50 per cent chance to double your wealth, and a 50 per cent chance to have your wealth fall by half. If A = 30, then you have the absurd implication of

contains risk that affects a large subset or all investments. It is the latter risk that is not diversifiable and should be rewarded. All risk and return models agree on this fairly crucial distinction but they are different when it comes to the issue of how to measure this market risk.

Modern asset pricing theory suggests that equity risk premia are predictable. Fama (1991) confirms the predictability of U.S. stock market in his survey of empirical studies whilst Bonomo, Ferris and Lamy (1991), Bekaert and Hodrick (1992), Campbell and Hamao (1992), Clare and Thomas (1992), Cochran, Defina and Mills (1993), all appear to corroborate the existence of the same pattern of predictability amongst international stock markets. The levels of predictability of stock returns are only predictable if we expect the dividend yield over the entire sample to be mean reverting. Goetzmann and Jorion (1995) show that the dividends yields show only marginal ability to predict stock returns in the United States and in the United Kingdom. They also argue that tests over long periods may be affected by survivorship bias. Simulations show that regression statistics based on a sample drawn solely from surviving markets can seriously be biased towards finding predictability.

Siegel (1999) says that most studies on US markets dating as far back as 1889 and 1926 are unlikely to predict the equity premium for the future. The real rate of return on fixed income assets is likely to be significantly higher than that estimated on earlier data. This Siegel says is confirmed by the yields available on treasury inflation-linked securities, which currently approach 4%. Furthermore, the return on equities is likely to fall from

being willing to pay 49 per cent of your wealth to avoid the 50 per cent chance of losing half your wealth. The MP paper has been enormously influential, and has spawned a whole new literature.

its former level due to the reduction in transactions costs and other factors which have driven equity prices higher relative to fundamentals.

All of the above factors, suggests Siegel, make it very surprising that Ivo and Welch (1998) found that most economists still estimate the equity premium to be around 5% to 6%. This would require a 9% to 10% return on stocks given the current real yield on treasury inflation-indexed securities. To prevent the P-E ratio from expanding further, real per share earnings would have to grow by nearly 8% to 9% per year given the current 1.2% dividend yield."

Siegel's study emphasises reversion to the mean. It seems to imply the bull market could rage on only if history was made or it we were entering a new paradigm. While not making predictions, the author is offering a warning based on available data.

We must note that Siegel's study is related to the US market and the factors behind Ivo and Welchs' (1998) findings don't necessarily apply to non-US markets. Jorian and Goetzmann (1999) suggest that the US is a very unique market by comparison with other large world equity markets. They state that in the beginning of this century, stock markets in countries like Russia, France, Germany, Japan and Argentina have suffered political turmoil, war and hyperinflation. Assuming there was some probability of disruption for the U.S. market, this probability is not reflected in the observed U.S. data. In turn, this will bias the estimates of the equity premium.

Lamont (1998) argues that dividends and earnings are important, but only for forecasting short-term movements in expected returns. The relative rate is uniformly unimportant and for long-horizon returns, price is all that matters. Recent low forecasts of returns are due to the fact that stock prices are high. Forecasting models suggest that investors look for dividends and earnings in the short-term, but in the long-term buy at low stock prices. This behaviour implies that today's market is appealing from a short-term but not a long-term viewpoint.

Goyal and Welch (1999) present a conditional and unconditional model for predicting the equity premium. The dividend yield is commonly thought to predict stock returns as does the historical equity premium average (unconditional) model. Goyal and Welch (1999) find that dividend yield regressions fail to predict out of sample but are good predictors for in sample estimates. Their main argument is the time-varying correlation between the dividend yield and expected returns. They then introduce a learning/changing market model, which suggests time-decay in the dividend yield coefficient. The challenge is to find a model other than the unconditional mean for predicting the equity premium. We cannot assume that the dividend yield model can predict the equity premium in the simple linear fashion usually presumed.

We use the lagged dividend yield to predict equity premia or stock returns. The various forms of dividend yield models are constructed and analysed in Chapter three. From this very basic approach we than move to the more spohisticated habit models in Chapter four. The argument put forward by Goyal and Welch is the ability of the model to predict in-sample and out-of-sample. The literature on the dividend yield model is covered in Ball (1978) and more recently in Rozeff (1984) Shiller (1984), Campbell and Shiller (1988), and Fama and French (1988). Cochrane (1997) provides an excellent survey of the equity premium literature.

Although Goyal and Welch show good in-sample predictive ability for annual equity premia, the dividend yield has poor out-of-sample predictive ability. There is some doubt about their procedure as the authors have used 20 years of data from 1926 to 1946 to predict from 1947 to 1997. This could result in biased estimates and hence make the results inaccurate.

An Australian study by Bellamy and Heaney (1997) explore the effect of the dividend yield, yield curve slope and level of interest rates. There is some evidence of statistically significant stock return volatility effects in the risk premium though this only appears in the post crash period.

Rozeff (1984) showed that dividend yields forecast equity risk premia, as would be predicted by a deterministic dividend discount model. For example, if the stock price represents a claim to the future stream of dividends, the price can be exactly determined assuming constantly growing dividends and a known discount rate. Under the Gordon growth model,

$$\mathrm{P(t-1)} = \frac{\mathrm{D(t)}}{\mathrm{r-g}} \qquad (2.1)$$

$$\mathrm{r} = \mathrm{g} + \frac{\mathrm{D(t)}}{\mathrm{P(t-1)}} = g + \frac{(1+g)\times D(t-1)}{P(t-1)} \qquad (2.2)$$

Where P is the stock price, D is the dividend, r is the discount rate and g is the constant growth rate of dividends. In our study the stock price is the All Ordinaries price index (an index excluding dividends).[5] In the certainty model, the discount rate is the expected return on the stock. Although the model is not directly applicable to the case in which growth rates and discount rates vary through time, the model suggests that dividend yield should capture variations in expected stock returns.

Data for Dividend Yield Model

Table 1 lists the data used in this paper. The study is based on monthly stock market data gathered from January 1973 to Oct 1999. The data is sampled from Datastream International™. The total market series (TOTMKAU) are calculated by Datastream International™ and are a market capitalisation weighted index incorporating approximately 80% of the market value at any given point in time. The reason we use TOTMKAU from Datastream is due to the lack of available indices calculated on a national basis that go as far back as 1973. Another reason is that in 1992 the Australian stock market benchmark index changed from the All Ordinaries index to the S&P ASX 200 index and as a result it would not be consistent and appropriate to use these indicies over our sample period.

The variables include the return index (RI) which includes reinvested dividends, the price index (PI) which excludes dividends reinvested. We used a 5-year bond rate as an approximation for the risk-free rate. The return index is equivalent to the value-weighted index (VWR) used in most United States studies and the price index is equivalent to the value-weighted index excluding dividends (VWRX). The equity premium is simply the difference between the return on the market with dividends and the risk free rate. Due to

[5] We must note that the return index (RI) used in this study should not be substituted for the price index

inconsistency of data availability from other sources, for example the unavailability of data on the return index (RI) from 1973 we had to use the Datastream series.

We split the sample into two sub-samples, one before the October 87 crash and one after the crash.[6] We need to exclude the crash period so see if the sample after the crash gives us different results, in particular values for the average equity premium and dividend yield.

The derived series of interest will be the equity premium, EQP, and the dividend yield, D(t-1)/P(t-2) and D(t-1)/P(t-1). The dividend yield is calculated as the difference between the value-weighted index with dividends and the value-weighted index excluding dividends[7]:

$$\mathrm{VWR}(t-1,t)-\mathrm{VWRX}(t-1,t) \equiv \frac{\mathrm{RI}(t)-\mathrm{RI}(t-1)}{\mathrm{RI}(t-1)}-\frac{\mathrm{PI}(t)-\mathrm{PI}(t-1)}{PI(t-1)} \equiv \frac{D(t-1,t)}{P(t-1)} \qquad (3)$$

We should make a note that $D(t-1,t)$ is the same as $D(t)$, given that we assume $D(t-1,t)$ are flows from last period to this period. The last term can be written as $D(t)/P(t-1)$. To compute $D(t)/P(t)$, we multiply by the market capitalisation ratio $P(t-1)/P(t)$.

[Insert Table 1: Data Sources]

[Insert Table 2: Descriptive Statistics]

(PI) as the RI includes dividends, not the type of price index used in the Gordon growth model.

[6] We exclude the observation in November rather then October as the data shows significant changes in the month after the crash.

Table 2a and 2b provides the descriptive statistics for the series. The mean, standard deviation and median are calculated as annual percentage returns, while the other statistics are based on findings from the monthly data. In table 2a the average log equity premium for the entire sample is 2.95% and the average log dividend yield is 4.13% per annum. The average log equity premium for the period before the 1987 crash is 4.70% and the average log dividend yield is 4.40%, which is higher than the entire sample period. The period after the crash gives an average log equity premium of 5.32% and a dividend yield figure of 4.13%. The average equity premium seems to be higher in the period after the crash when compared to the period before the crash. This finding is not surprising, as the Australian market has performed exceptionally well since the crash.

The reported skewness for the three periods is negative and statistically significant, indicating that large negative returns are more frequent than large positive returns. The skewness for the entire period is very high compared to the two smaller sub-samples. This is not surprising, as there were significantly high negative returns in the 70s and 80s. The skewness after the crash is relatively low, indicating once again a steady flow of positive returns and very small negative returns on the market. Finally, the reported measure of excess kurtosis indicates that large returns occur more frequently than would be the case if returns were normally distributed. As is pointed in Fama (1965), one explanation for the excess kurtosis in stock returns is that the variance of returns is not constant over time.

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[7] For index calculation please see Appendix A on page 116.

Figure 1 plots the time series of the equity premium and the dividend yield. The EQP graph shows significant volatility from the mid-70s to the late 80s. The bond market has performed significantly better than the returns on equities, thus rendering an overall low equity premium. The equity premium seems fairly stationary unlike the dividend yield, which, like most studies is found to be non-stationary. The figure also shows the existence of structural breaks over the sample period making it difficult to set up a model for future predictions, but the graphs are good indicators of the movements in the dividend yield and the EQP.

Stambaugh and Pastor (2001) express concern about the estimation of the equity premium when structural breaks are present. Data before a break are relevant if one believes that large shifts in the premium are unlikely or that the premium is associated, to some degree, with volatility. Stambaugh and Pastor (2001) develop and apply a Bayesian framework for estimating the equity premium in the presence of structural breaks. This study is beyond the scope of this paper and we will try to apply different methods to forecasting the equity premium.

[Insert Figure 1: Time Series Graphs]

In-Sample Fit and Out-of-Sample Forecasting

Forecast Evaluation statistics

Although the creation of good parameter estimates is often viewed as the primary goal of econometrics, to many a goal of equal importance is the production of good economic forecasts. We define the best forecast as the one, which yields the forecast error with the minimum variance. In the single equation regression model, ordinary least-squares estimation yields the best forecast among all linear unbiased estimators. One important statistic is the forecast error variance but there are several ways in which we can measure the forecasting accuracy of a model. In this study we look at the mean absolute error (MAE), root mean square error (RMSE), mean absolute percentage error (MAPE)[8]. The mean squared error (MSE), a predictor can be broken down into three parts. The first, called the *bias proportion*, corresponds to that part of the MSE resulting from a tendency to forecast too high or too low, reflected by the extent to which the intercept term in the regression of actual changes on predicted changes is nonzero. The third, called the *variance proportion*, measures that part of the MSE resulting from an unpredictable error (measured by the variance of the residuals from this regression). This decomposition (see Theil, 1966) provides useful information to someone attempting to evaluate a forecasting method.

A common statistic applied in the forecasting context is Theil's inequality (or "U") statistic (see Theil, 1966), which is given as the square root of the ratio of the mean square error of the predicted change to the average squared actual change. For a perfect forecaster, the statistic is zero; a value of unity or close to it corresponds to a forecast of "no change." (Note that an earlier version of this statistic has been shown to be defective; see Bliemel, 1973).

[8] For a brief description of these forecasting measurements see Appendix B on page 116.

In-sample forecasts

Table 3 correlates the equity premium with the lagged dividend yield and lagged dividend yield changes. We have again estimated bivariate regressions on the three samples. The first equation is based on the lag of the dividend yield based on last year's price; the second uses the lag of the current price. The last two equations were estimated on an experimental basis to see whether or not the changes in dividend yield or the differences, have any explanatory power for movements in the equity premium. The bivariate regressions are based on the following equation.

$$EQP = \alpha + \beta DVYIELD \tag{4}$$

where dividend yield is either $D(t-1)/P(t-2)$ or $D(t-1)/P(t-1)$ and the last two equations are the difference between last years dividend yield and the year before, again using the two different prices.

The results in all three samples are very weak. In the first sample (Feb 73 to Oct 99), our specifications differ slightly from earlier work (as earlier work does from one another), but our conclusions are different from those of Goyal and Welch (1999) and the Fama and French (1988) specifications. The sample dividend yield regressions for the three sample sizes show different results when compared to the findings presented in Goyal and Welch (1999).

The more common D(t - 1)/P(t - 2) performs better for the entire sample and the period before the crash than the (perhaps more uncommon) D(t - 1)/P(t - 1). Table 3 also shows that, although the dividend yield is a non-stationary variable, changes in the dividend yield do not offer improved fit for the first two sample estimates. The sample after the crash shows a better fit with the dividend yield changes as the independent variable. Our interpretation of a good fit is based on the adjusted R^2 estimates. Using the dividend yield changes based on the difference report some mixed results in predicting the equity premium. The model represented by the lagged differences, using the current price, ie., [D(t-1)/P(t-1) – D(t-2)/P(t-2)] shows the best fit between all four regressions when we the entire sample period is used.

The conclusions drawn from Table 3 are as follows. The dividend yield seem to loose its explanatory power as we progress through the sample period. The more common lagged dividend yield model based on last year's price seems to be a better predictor. This finding has been supported in most of the literature, except where Goyal and Welch (1999) find the model based on the current price is the best predictor. They do however note that their finding may not necessarily be true for other markets in different countries, but they do question previous studies based on US data.

Out-of-Sample Forecasts

Unfortunately, even a sophisticated trader could not have used the regression in Table 3 to predict the equity premium. Most rational decision-makers do not work with complex model to make their decisions. A trader could only have used a simple model based on past values of the equity premium in attempting to forecast next years value. This is why we display statistics on the prediction errors when the dividend yields model and the unconditional equity premium means forecast are estimated only with historical data. We forecast using two different data sets, one utilising the full sample period and the other from December 1987 to Oct 1999. We exclude the period between February 1973 and the October 1987 due to the high inaccuracy in prediction with out-of-sample estimates. These forecast evaluation statistics are reported in Table 4.

In each box, the first two data columns contain the in-sample prediction errors from the single full period regression model as in Table 3. To do an out-of-sample comparison, we need an initial period to estimate coefficients. Thus we chose (ex ante) the post-crash period (Dec 1987 - Oct 1999) as our out-of sample window. The second two data columns display the in sample Dec 1987 - Oct 1999 residuals standard error from out single full-period regression. The final two data columns display the statistics of most interest: the performance of the out-of-sample rolling prediction errors for the Dec 1987 to Oct 1999 period. Again, each year we use only available historical information to estimate the dividend yield regression. The regression coefficients are used to forecast the equity premium, and the statistics are over the sum-total of out-of-sample single year forecasts errors. The out-of-sample benchmark and null hypothesis is that the next year's equity return is simply the same as the historical average, up to this date. This is denoted as UNC (unconditional [ie., without dividend yield conditioning]).

Table 3 had indicated that annual equity premia are well predicted in sample. The top panel considers $D(t-1)/P(t-2)$. The first two data columns of Table 4 show that, when compared to the dividend yield model the unconditional model results in a lower RMSE (root mean square error) than the dividend yield model. The lowest RMSE is observed when we forecast in and out-of-sample for the period after the crash. The Theil's coefficient is very high in most of the sample windows, but during the period prior to the crash is found to be 0.67 for the dividend yield model and 0.68 for the unconditional. This finding indicated that a model based on this period is good one for predicting the equity premium.

One might object to our findings based on issues of statistical power. However, it is unclear what modifications one should make to increase power. Both the null hypothesis (unconditional mean) and the alternative hypothesis (the regression model) are clearly defined in the literature, as are the metrics on which they are compared to i.e., the test for parameter stabiligy measure by the RMSE and MAE.

Given the poor out-of-sample performance, our first question is how an investor should view the out-of-sample misprediction evidence in evaluating the linear dividend yield models. We thus develop a simple test for model stability in the dividend-yield prediction context. We must adjust for the fact that when the dividend yield is almost a random walk, it can bias the estimated dividend yield coefficient, as pointed out by Stambaugh (1999) and Yan (1999).

$$EQP(t) = x_1 + x_2 \times DVY(t-1) + \varepsilon_E(t)$$
$$DVY(t) = x_3 + x_4 \times DVY(t-1) + \varepsilon_D(t)$$

$$\begin{pmatrix} \varepsilon_E(t) \\ \varepsilon_D(t) \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} x_5 & x_6 \\ x_6 & x_7 \end{pmatrix} \times 10^{-3}\right]$$

where EQP is the equity premium and DVY is the dividend yield, either D(t-1)/P(t-1) or D(t-1)/P(t-2). As before, EQP and DVY are quoted in logs.) We want to match (using some functional specification) the empirically observed 1973:03 to 1999:07 data sample moments:

Dividend Yield	X_1	X_2	X_3	X_4	X_5	X_6	X_7
$D(t-1)/P(t-2)$	-0.035	10.816	0.000	0.897	28.35	0.882	0.092
$D(t-1)/P(t-1)$	-0.029	8.925	0.000	0.827	26.56	-0.731	0.007

One can of course not use the data moments as best models estimates. It is well-known that if the true x_4 is close to 1, the sample x_4 is biased downward; and Stambaugh (1999) and Yan (1999) suggest that inference on x_2 is similarly biased if the true (not sample!) x_4 is close to 1. Our own goal is not to obtain inferences (i.e., significance levels) about x_2, but to test if the best stable model that fits the 1973:3 to 1999:7 data can generate poor out-of-sample performance in line with that observed in the real empirical data.

Impulse Response Functions

In response to the rigid identifying assumptions used in theoretical macroeconomics during the seventies, Sims (1980) provided what has become the standard in empirical macroeconomic research; vector autoregressions (VAR). Since then, researchers in macroeconomics often compute dynamic multipliers of interest (such as impulse response and forecast-error variance decompositions) by specifying a VAR, even though the VAR per se is, often times, of no particular interest. However, VAR-based impulse response functions are restrictive in a manner seldom recognised. In particular impulse responses are constrained to have the following properties[9] : (1) *symmetry,* responses to positive and negative shocks are mirror images of each other; (2) *share invariance,* responses to shocks of different magnitudes are scaled version of one another; (3) *history independence,* the shape of the responses is independent of the local conditional history; (4) *multidimensionality,* responses are nonlinear functions of highdimensional parameter estimates which complicate the calculation of standard errors and have the potential of compounding misspecification errors; and (5) *linearity*, a VAR is a representation of linear, stochastic difference equations that may not appropriate represent more general economic processes.

Impulse responses are important statistics in their own right and thus avoiding these constraints is a natural empirical objective. Based on this we test the response function of out simple dividend yield regression model. I do not present the complex econometrics behind this methodology in this dissertation due to the fact that we just apply here independent of VAR models. This form of application has just started to appear in the literature at the working papers series level and to the best of my knowledge it is not published yet. Given that we have not approached cur analysis based on Vector Auto Regressive model does not necessarily mean we cannot use impulse response function approach in testing the dynamics of the estimating equation. Jorda (2004) introduces methods for computing impulse response functions that do not require specification and estimation of the unknown dynamic multivariate system itself. The central idea behind this method is to estimate flexible local projections at each period of interest rather than extrapolating into increasingly distant horizons from a given model, as it is usually done in vector autoregressions (VAR). The advantages of local projections are numerous: (1) they can be estimated by simple regression techniques with standard regression packages; (2) they are more robust to misspecification; (3) standard error calculation is direct; and (4) they easily accommodate experimentation with highly non-linear and flexible specifications that may be impractical in a multivariate context. Therefore, these methods are a natural alternative to estimating impulse response functions from VARs.

[9] The following list of properties is mostly in Koop et al., 1996.

The generalised impulse responses from one standard deviation shock to each of the variables are traced out in Figure 3a and 3b. We use generalised impulse response functions because they are not sensitive to the ordering of the variables in the equation and do not assume that when one variable is shocked, all other variables are switched off. I am simply trying to attempt to guage to what extent shocks to certain variables are explained by other variables particularly the impact on Equity Premium when other variables are shocked.

In Figure 3a we show the reponses prior to 1987 in a bid to see if dividend yields shocks had a different impact on equity premia as opposed to post 1987. This was merely done due to the fact that most of the literature in the 1980s supported the role of dividend yield in predciting stock returns and or market risk premiums. The response of EQP to LDVYIELD shows lasting effect on the equity premium when lagged dividend yields are shocked. This can be interpreted as, shocks in dividend yield impact the risk premium and hence could play a signifcant role is explaining movements in the risk premium. The response of equity premium in figure 3b shows that risk premium settle back to their pre-shock level rather quickly. This could be the fact that dividend yields have become poor estimators of risk premiums since the 1987 crash and are no longer suitable. The form of analysis has never been done and researcher's have used less naïve models to show that dividend yield are no longer good predictors of the equity premium.

Conclusion

Although the objective of this research was to provide some insight into changes in the stock market risk premium over time, the CAPM and other asset pricing models show that the risk premium of interest to investors is an ex-ante measure. As a result the direct observation of this premium is not feasible.

This paper has shown that the predictive capability of the dividend yield model has declined for out-of-sample estimates, but generally results in good in-sample estimates. Good in-sample performance is no guarantee of out-of-sample performance in the equity premium prediction context. The simple dividend-yield predictions over the 1987:12 to 1999:07 period cannot beat the unconditional historical average equity premium on average, much less do so in a statistically significant manner. A naive market-timing trader who just assumed that the equity premium was "like it has been" would typically have outperformed a trader who was employed dividend yield model. We have also seen from impulse response functions that, after 1987, shocks to dividend yields had less effect on response of the equity premium as oppose to significant disequilibrium in the long run time path of the equity premium prior to the 1987 crash. From the 1990s onwards there has been a shift from dividend payments to share buyback etc and several research papers have emerged on whether dividends are dissapearing from the equity market.

Table 1:Data Sources

Name	Description	Source	Availability
RI	Return Index (including dividends)	Datastream	Feb-1973-Oct 1999
PI	Price index (excluding dividends)	Datastream	Feb-1973-Oct 1999
BD	1 month bond rate	Australian Bureau of Statistics	Feb-1973-Oct 1999
EQP	The equity premium	VWR-BD	Feb 1973-Oct 1999
D(t-1)/P(t-2)	The dividend yield	VWR-VWRX	Feb 1973-Oct 1999
D(t-1)/P(t-1)	The dividend yield	D(t-1)/P(t-2)×[P(t-1)/P(t)]	Feb1973-Oct 1999

Explanation: Parenthesised expressions denote timing. When omitted, assume a time subscript of zero. In all regressions that follow, EQP will lead its predictors by one period. For example, the January 1988 dividend yield (e.g., D (December 1987 to January 1988)/P(Dec1987) would be used to forecast February 1988 equity premia EQP(January 1988 to February 1988)

Table2a: Descriptive Statistics

Entire Sample Period, Feb-1973 to Oct-1999

		In Levels			In Logs								
	N	**Mean**	**Sdev.**	**Median**	**Mean**	**Sdev.**	**Median**	**Min**	**Max**	**Skew**	**Kurt**	**JqBr**	**ADF**
VWR	318	16.55	6.31	17.70	13.55	6.43	17.28	-44.52	20.40	-1.248	11.017	911.97	-8.027
VWRX	318	11.78	6.29	12.86	9.08	6.43	12.79	-44.79	20.11	-1.254	10.957	899.39	-8.013
BD	318	10.34	0.22	10.00	10.33	0.23	9.99	0.38	1.29	-0.044	1.944	14.04	-2.021
EQP	318	5.67	0.06	8.43	2.95	6.44	7.66	-45.52	19.57	-1.266	11.084	925.70	-7.937
D(t)/P(t-1)	318	4.31	0.08	4.12	4.13	0.44	4.09	-6.09	3.13	-8.875	152.056	85.98	-3.778
D(t)/P(t)	318	4.27	0.08	4.08	4.13	0.43	4.08	-5.75	3.22	-8.151	142.066	97.48	-3.798

Sample Period Prior to the 1987 crash, Feb-1973 to October-1987

		In Levels			In Logs								
	N	**Mean**	**Sdev.**	**Median**	**Mean**	**Sdev.**	**Median**	**Min**	**Max**	**Skew**	**Kurt**	**JqBr**	**ADF**
VWR	177	20.12	7.01	18.15	16.61	6.95	18.02	-22.87	20.4	-0.29	3.97	9.34	-5.922
VWRX	177	15.05	6.98	13.94	11.74	6.96	13.85	-23.26	20.11	-0.30	3.96	9.38	-5.908
BD	177	11.42	0.19	11.78	11.42	0.19	11.78	0.43	1.29	-0.12	2.18	5.44	-1.855
EQP	177	7.88	7.01	6.84	4.70	6.95	6.73	-23.66	19.57	-0.28	3.96	9.13	-5.718
D(t)/P(t-1)	177	4.46	0.09	4.31	4.40	0.001	4.31	0.21	0.69	0.92	4.42	39.96	-2.041
D(t)/P(t)	177	4.41	0.09	4.31	4.38	0.09	4.23	0.2	0.75	0.93	4.74	47.56	-2.254

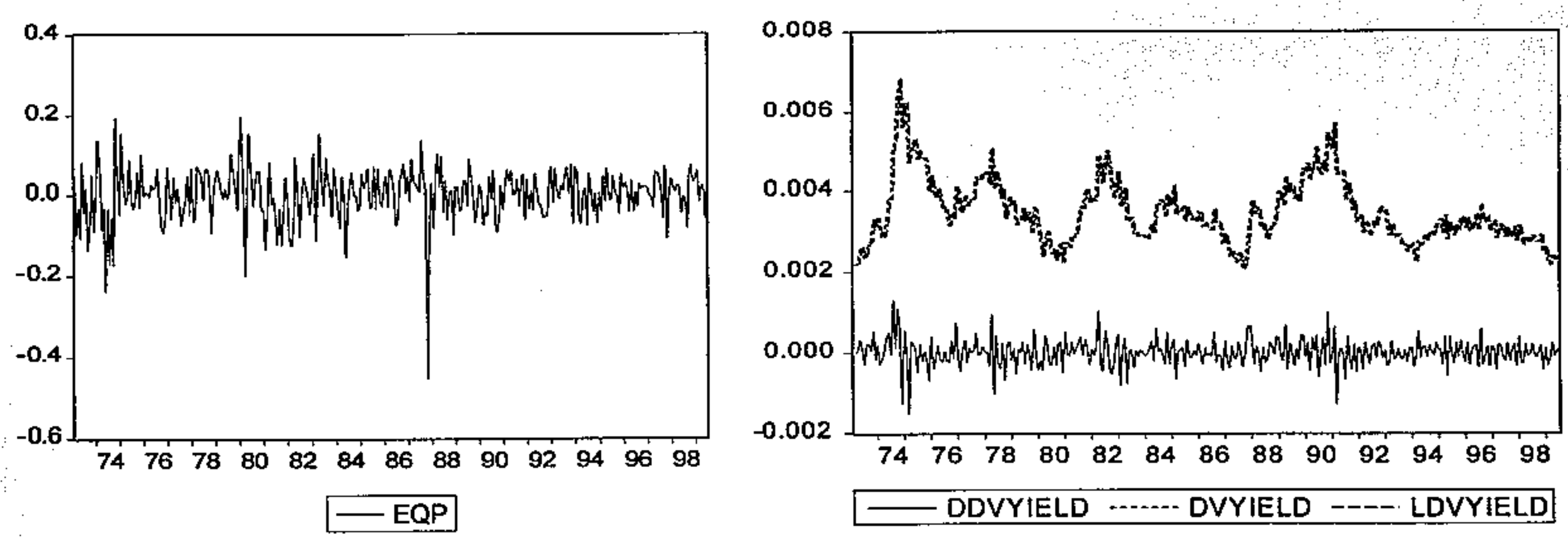
Table2b: Descriptive Statistics

Sample Period after 1987 crash, Dec-1987 to Oct-1999

		In Levels			In Logs								
	N	**Mean**	**Sdev.**	**Median**	**Mean**	**Sdev.**	**Median**	**Min**	**Max**	**Skew**	**Kurt**	**JqBr**	**ADF**
VWR	140	16.26	4.44	19.40	14.84	4.39	19.24	-9.75	11.6	-0.13	2.41	2.41	-5.922
VWRX	140	11.64	4.43	15.15	10.32	4.4	15.05	-10.07	11.24	-0.13	2.4	2.45	-5.908
BD	140	9.08	0.23	8.42	9.08	0.23	8.43	0.38	1.15	0.35	1.9	10.04	-1.855
EQP	140	6.63	4.46	8.63	5.32	4.42	8.52	-10.23	10.71	-0.14	2.37	2.78	-5.718
D(t)/P(t-1)	140	4.17	0.07	3.93	4.13	0.07	3.93	0.22	0.57	1.02	3.8	27.79	-2.041
D(t)/P(t)	140	4.13	0.07	3.94	4.10	0.07	3.90	0.22	0.57	1.01	3.82	27.6	-2.254

Explanation: All series are described in Table 1. Throughout the paper, they are measured on a continuously compounding basis. Except where otherwise indicated, the paper reports only results using log variables. Log always means the natural log of 1 plus the value. Every mean and median is significantly different from zero at the 1% level. JqBr is the Jarque-Bera (Jarque and Bera (1987)) test of normality. The critical level of reject normality is 5.99 at the 95% level, 9.21 at the 99% level. ADF is *Augmented Dickey-Fuller* including constant and time trend (Dickey and Fuller (1979)) test for the absence of a unit root. For sample period up to the 1987 crash the ADF values of -4.01 reject the presence of a unit root at the 1% level (-3.437 at the 5% level; -3.142 at the 10% level). For the sample period after the 1987 crash the ADF the critical values are -4.03 at 1% level; -3.44 at 5% level and -3.15 at the 10% level. For the entire sample the critical values are -3.99 at 1% level; -3.43 at 5% and -3.14 at the 10% level.
The results from the three tables are discussed in the main text. All the variables are reported on monthly data, except, the mean and median are reported on an annual basis. We split the sample into 3 different periods to see if the equity premium and dividend yield vary differently prior to the October 87 crash are the period after the crash. We compare the results from these two periods with the entire sample. We exclude data from November 1987 due to the dramatic decline resulting from the October 1987 crash.

Figure 1: Time series Graphs



Explanation: The left graph plots the time series of the log equity premium (EQP). The right graph plots the dividend yield and changes in the dividend yield.

Table 3: Bivariate Regressions Predicting the Equity Premium (EQP) In-Sample

	Sample Period: Feb73 to Oct 99					
Dividend Yield is	**CONST**	**Dividend yield**	R^2	$\overline{R}$	**s.e.**	**N**
$\left[\frac{D(t-1)}{P(t-2)}\right]$	-3.538 -2.159 -2.038	10.816 2.369 2.338	1.75	1.44	6.44	317
$\left[\frac{D(t-1)}{P(t-1)}\right]$	-2.862 -1.822 -1.636	8.925 2.034 1.862	1.30	0.98	6.46	317
$\left[\frac{D(t-1)}{P(t-2)}\right]-\left[\frac{D(t-2)}{P(t-3)}\right]$	-2.750 -1.668 -1.630	8.639 1.883 1.955	1.12	0.80	6.45	316
$\left[\frac{D(t-1)}{P(t-1)}\right]-\left[\frac{D(t-2)}{P(t-2)}\right]$	-4.760 -2.011 -1.231	13.658 2.127 1.488	2.52	1.96	7.66	316

Explanation: Variables are described in Table 1, their descriptive statistics are in Table 2. The dependent variable, the (log) equity premium at year t (in percent), leads the independent variables by one year in all cases expect in the first case where we use the current dividend yield. The first row of each regression model is the coefficient, the second line its OLS t-statistic, the third line its Newey-West heteroskedasticity and autocorrelation adjusted t-statistic. The standard error (s.e.), R^2 and $\overline{R}^2$ (adjusted R^2) are quoted in percent.

Dividend Yield is	Sample Period: Feb73 to Oct 87						Sample Period: Dec 87 to Oct 99					
	CONST	Dividend yield	R^2	$\overline{R}$	s.e.	N	CONST	Dividend yield	R^2	$\overline{R}$	s.e.	N
$\left[\frac{D(t-1)}{P(t-2)}\right]$	-3.841 -1.688 -1.780	11.655 1.896 2.147	2.02	1.46	6.92	176	0.235 0.125 0.121	0.586 0.108 0.101	0.01	-0.72	4.43	140
$\left[\frac{D(t-1)}{P(t-1)}\right]$	-2.91 -1.345 -1.257	9.135 1.557 1.482	1.37	0.81	6.94	176	0.404 0.223 0.213	0.586 0.016 0.015	0.00	-0.72	4.44	140
$\left[\frac{D(t-1)}{P(t-2)}\right]-\left[\frac{D(t-2)}{P(t-3)}\right]$	-2.184 -0.945 -1.057	7.193 1.155 1.424	0.77	0.19	6.94	176	-0.369 -0.198 -0.191	2.377 0.439 0.409	0.14	-0.58	4.43	140
$\left[\frac{D(t-1)}{P(t-1)}\right]-\left[\frac{D(t-2)}{P(t-2)}\right]$	-2.509 -1.376 -1.231	8.138 1.376 1.488	1.08	0.51	6.93	176	-0.369 -0.191 -0.087	2.377 0.409 0.336	0.14	-0.58	4.43	140

Explanation: The above two sample periods are used to investigate any differences in parameter values caused by the October 87 crash. The table shows good results up to the crash period, but since December 87 the dividend yield model does not fit the given data. Our conclusion here is simply that the dividend yield has lost its explanatory power in predicting future equity premia movements.

Table 4: Properties of Forecast Errors Predicting the Equity Premium (EQP) Out-of-Sample

D(t – 1)/P(t – 2) as Forecaster

	in-sample(Feb-1973 to Oct 1999)		in-sample(Feb-1973 to Oct 1987)		in-sample(Dec-87 to Oct 99)		out-of-sample(Dec-87 to Oct 99)	
	DV	UNC	DV	UNC	DV	UNC	DV	UNC
RMSE	6.42	6.38	6.88	6.95	4.47	4.53	4.48	4.50
MAE	4.71	4.62	5.31	5.39	3.69	3.71	3.70	3.70
MAPE	199.98	188.23	198.20	196.7	202.95	192.35	210.01	210.81
TIC	0.87	0.81	0.67	0.68	0.86	0.83	0.86	0.87
Bias Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variance	0.77	0.71	0.77	0.81	0.67	0.72	0.65	0.69
Covariance	0.23	0.18	0.23	0.27	0.33	0.39	0.34	0.31

Explanation: This table describes the univariate properties of log equity premium prediction errors from one model that conditions on lagged dividend yield (**DV**), and another model that uses only the historical avearge log equity premium as a forecast (**UNC**). The first two data columns compare the residuals of a single large regression with data from February 1973 - June 1999, with the overall unconditional average over the entire period. The second two columns contain the in-sample estimates from the beginning of 1973 to the crash in 1987. The third column is included to compare the prediction error before and after the crash. The last two columns use only historical information from 1973 to October 1987 to produce each forecast. Thus each year the dividend yield regression and unconditional model are reesimated with data available up to date in order to obtain an equity premium forecast (and forecast error). The RMSE is the root mean squared error, MAE is the mean absolute error, MAPE is the mean absolute percentage error, TIC is the Theil inequality coefficient. The above table is estimated using only D(t-1)/P(t-2) as a forecaster while the following table is estimated using D(t-1)/P(t-2) as a forecaster.

Table 4 continued: Properties of Forecast Errors Predicting the Equity Premium (EQP) Out-of-Sample

D(t – 1)/P(t – 1) as Forecaster

	in-sample (Feb-1973 to Oct 1999)		in-sample (Feb-1973 to Oct 1987)		in-sample(Dec-87 to Oct 99)		out-of-sample (Dec-87 to Oct 99)	
	DV	**UNC**	**DV**	**UNC**	**DV**	**UNC**	**DV**	**UNC**
RMSE	6.42	6.38	6.90	6.39	4.57	4.63	4.46	4.49
MAE	4.71	4.62	5.33	5.64	3.67	3.69	3.66	3.75
MAPE	199.98	188.23	195.57	193.56	181.58	183.56	184.49	188.56
TIC	0.87	0.81	0.88	0.85	0.88	0.83	0.87	0.91
Bias Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variance	0.77	0.71	0.79	0.69	0.71	0.78	0.71	0.73
Covariance	0.23	0.18	0.21	0.26	0.28	0.31	0.29	0.29

Explanation: From the above table and the one previous, we can see that the statistics are very similar to the one in the previous table. A further explanation to these findings is reported in the main body of this Chapter.

Figure 2: Dividend Yield forecast Evaluation Graphs using $D(t-1)/P(t-2)$ as a forecaster

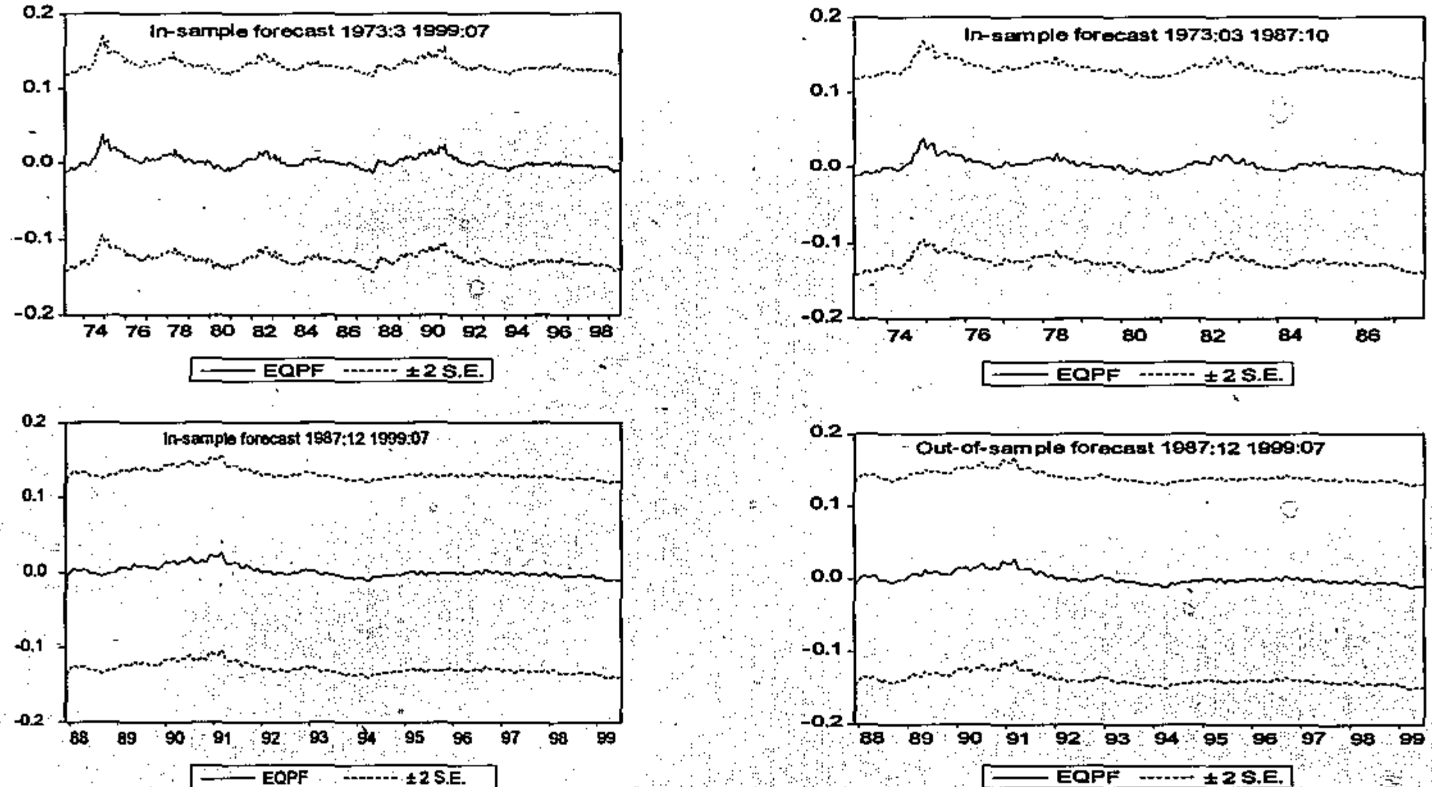
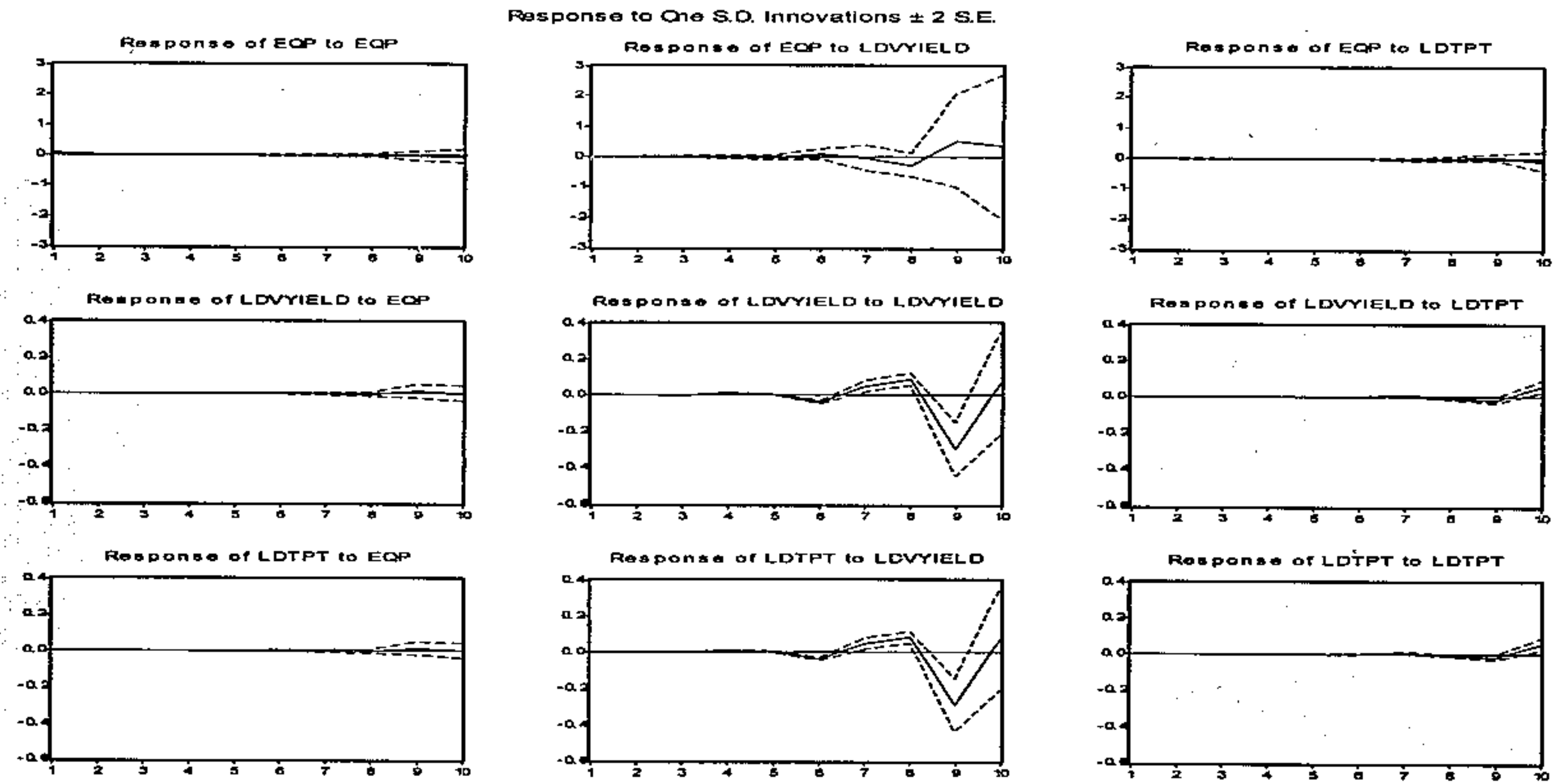
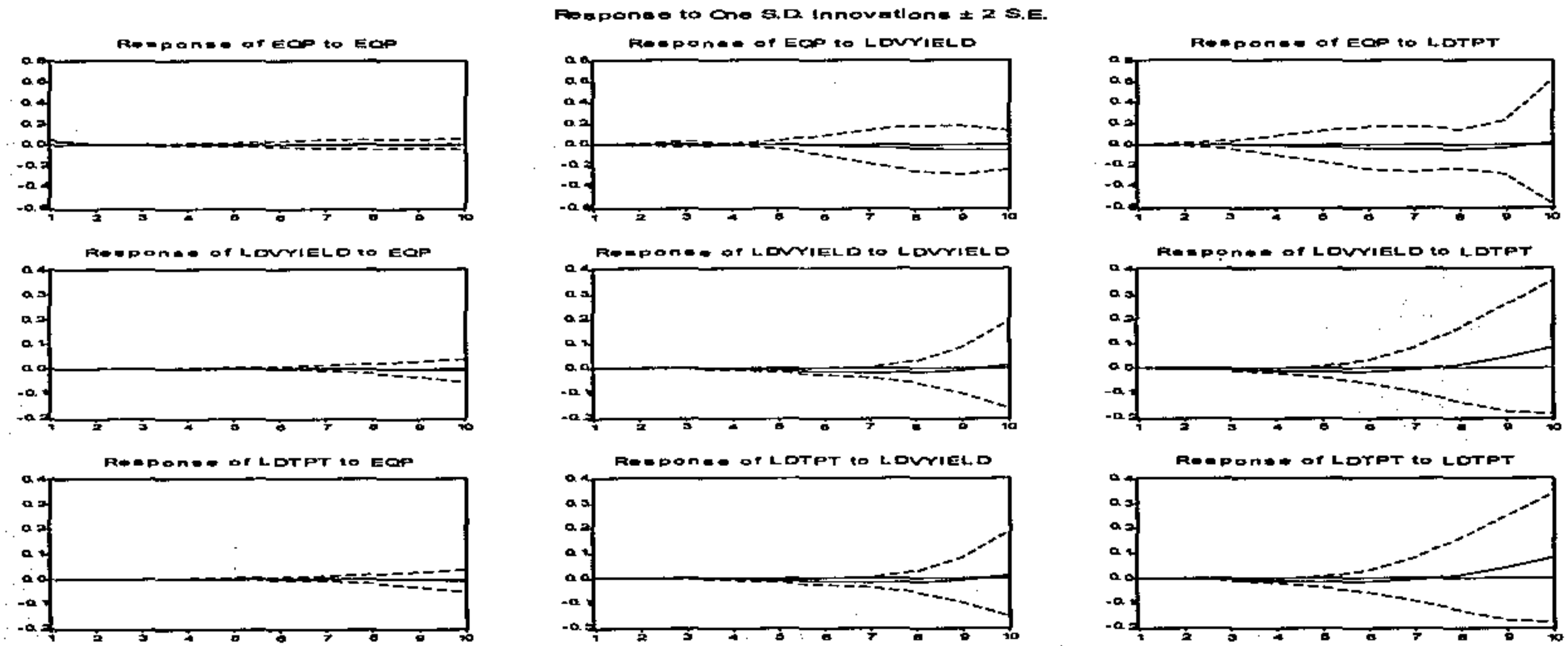


Figure 3a: Impulse response functions on the different variables for the entire sample



The above impulse response functions show response of different variables when a one standard deviation shock is imposed of a particular variable. The most important observation is the response of EQP to LDVYIELD. It shows the severe disequilibrium in the long run time path of the equity premium when lagged dividends experience a 1-standard deviation shock.

Figure 3b: Impulse response functions on the different variables for the sample period after the 87 crash.



Chapter 3

CCAPM, CRRA and the Equity Premium

In thie chapter we discuss the assumptions of a representative agent and aggregation. Both assumptions are required for CRRA and habit models, but this section explains that habit models are less restrictive. Then the general CCAPM model is derived. These identities are the basis of all CCAPM models. The coefficient of risk aversion is derived to prove that to be properly defined it should be separable from intertemporal choice. Then the CRRA CCAPM is derived based on the CCAPM identities to show that CRRA utility cannot separate the coefficient of relative risk aversion from intertemporal choice. Thereby the CRRA utility function is shown to be rejected on a theoretical grounding.

Before we start explaining the dynamic of these habit and risk aversion models we need to explain the concept of utility to our readers. Utility is the cornerstone of modern economics. On the premise that people strive for 'happiness', economics grew from philosophical political economy to the pseudo-science today – pseudo in the sense that the axioms of economics are not universally accepted in the same way that the axioms of other sciences have been. For example, most people accept the logic of addition and subtraction, but individualism and rationality are more controversial. Kreps and Porteus (1978) present the problem as it applies to choice behaviour:

'Choice behaviour is which an individual distinguishes between lotteries based on the times at which their uncertainty resolves is axiomitised and represented, thus the

result is choice behaviour which cannot be represented by a single cardinal utility function on the vector of payoffs'. Pp 185

Nonetheless, economics must model people using mathematics to enable theory to be empirically tested. The main problem with mathematical modelling is that functions can be chosen for computational simplicity rather than representing the human action being modelled. For example, when deriving the CCAPM the graduate textbook 'Foundation of International Economics (Obstfeld and Rogoff, 1996) states on the use of CRRA utility

> *'Not withstanding this drawback [of time and state inseparability], the need for tractability leads us to retain the expected utility assumption, and we continue to specialise to CRRA preferences when it is useful to do so.'p279*

Perhaps it was tractability, or perhaps a genuine belief that people have constant risk aversion that lead researchers to use CRRA expected utility when deriving the consumption CAPM. Regardless, Mehra and Prescott (1987) challenged the use of such utility with the publication of "The Equity Premium – A puzzle'. The puzzle states that the risk premium on equity is unrealistically high. Basically Mehra and Prescott found that difference between the return on the market portfolio and a riskless rate could only be accounted for using a very high coefficient of risk aversion. Constantindes (1990) restates the puzzle as the problem of consumption growth being too smotth, and Weil (1989) restates is as the risk free rate puzzle. The main conclusion is that CRRA utility is not empirically satisfying. The equity premium puzzle raised a more important problem. If expected utility does not fit, then agents are not forward looking, and so there may be no role for rational expectations in consumption choice (Deaton, 1987 and Pollak, 1970 for the rejection of rationality based on the existence of habit).

Some researchers find that the equity premium puzzle is the result of market frictions, and not the product of flawed theory (Modest and He 1995, Heaton and Lucas 1996). Modest and He (1995) found that removing liquidity constraints resolves the puzzle. They perform diagnostic tests for consumption based asset pricing models in the presence of market frictions. In particular, they examine theoretically and empirically the impact of short-sale restrictions, borrowing constraints that prevent borrowing against future labour income, solvency constraints that restrict the wealth process, and transaction costs on the equilibrium relation between comovements in consumption and asset returns. Their results show that none of the frictions alone – with the possible exception of solvency constraints – can explain the apparent rejection of the first-order equilibrium conditions between consumption and asset returns, discovered by many researchers. However, a combination of short-sale and borrowing constraints and trading costs does not yield a rejection of the model. The authors acknowledge a weakness in their approach in that their diagnostic tests, which generally take the form of inequality restrictions, are like to be significantly weaker than the standard tests fo equality restrictions. Nonetheless, this study retains the assumption that markets are perfect, and concentrates on the shortcoming of the CRRA utility analysis and the benefits of habit utility. The literature finds three undesirable assumptions for equity pricing from CRRA utility.

Firstly, as the name suggests, agents have a constant relative risk aversion. This means that present wealth is inconsequential to an agent's decision when considering a risky venture. Kreps and Porteus (1978) argued that this is not necessarily realistic. Using temporal resolution they argued that risk aversion depended on the timing of the resolution of uncertainty – a time varying risk aversion. Kreps and Porteus (1978) and Lucas (1978) first extended the general utility CRRA function into the recursive function used by Epstein and Zin (1989). Epstein and Zin separate risk aversion and the elasticity of intertemporal substitution by introducing habit which can allow for time varying risk aversion.

The second assumption is that agents obtain utility form the level of consumption. The problem with this assumption is best viewed in the very long run. A representative agent from the 1950s had a substantially lower consumption level than an agent of the 1990s. If consumption levels are counted, than the agent of the 1990s should be happier. However, studies (Easterlin 1974, 1995, Duncan 1975) show that happiness is not significantly different through time. Instead, they find that it is contemporaneous relative income that distinguishes happiness.

Thirdly, CRRA assumes time separability of preferences. This means current consumption will be unaffected by past consumption behaviour. Obstfeld and Rogoff (1996) can identify six reasons for retaining time separability. However, all six rely on the agent being an individual rational maximiser in the tradition of von Neumann-Morgenstern. Time separability preferences take for granted the assumption that agents will behave with such exogenous preferences. Epstein and Zin (1989), Abel (1990) and Constantindes (1990) relaxed the time separability assumption, and allow for complementarity in consumption. Their results indicated a partial resolution to the equity premium puzzle. Some researchers (Epstein and Zin (1989) suggested that the empirical failing of expected utility functions compared with habit utility functions meant that the rejected of rational expectations. On the other hand Constantinides (1990) presented a model in which future consumption preference are based on rational expectations as well as considerations of past consumption. It is the inclusion of rational habit formation that is extended in this study.

Habit to varying degrees, requires agents to choose their current level of consumption based on previous levels. Their choice may or may not incorporate expectations of future income. There are two forms of the basic habit consumption model. Abel (1990) proposed a "catching up with the Jones" model whereby consumption preferences are external and depend on the aggregate consumption patterns. Agents choose consumption based on their findings for the level of consumption other people are consuming. In this case information can be through of as being derived from the local community, neighbours and probably the media. Abel proxies these influences using aggregate consumption. The second form is internal habit. Constantinides (1990) and Sundareson (1989) used internal habit, so that the agent makes decisions based on personally experienced consumption levels. This study adopts Abel's external preference definition of habit.

A further issue was the speed at which habit adjusts. Hall's (1978) consumption as a random walk implies that consumption will react immediately to shocks. Abel (1990) suggested that habit levels are not the one period lag of consumption, whereas Campbell and Hamao (1992) used exponentially decaying habit. This study model habit using an AR(1) process.

There is now a large amount of recent empirical literature (Alessie and Lusardi 1997, Mistri 1998) to support habit utility (also known as recursive utility), but there is a danger of falling into the same trap as early researchers did with CRRA power utility by making improbable assumptions. Habit utility as a model of human economic behaviour should make practical sense for it to be considered as serious rival of CRRA utility. In the next paragraph, habit is presented in the context of explaining real human actions or emotions.

Habit could be a form of myopia. In this sense agents do not predict the future because they assume it to be the same as the past. This was the basis of the argument presented by authors proposing that the equity premium puzzle meant a rejection of rational expectations (Pollak 1970, Deaton, 1987). Alternatively habit utility can be interpreted to model "catching up with the Jones" psychology. This type of model can account for the paradox of Easterlin (1974, 1995), who found that happiness was not correlated with increased consumption. Catching up with the Jones psychology could be described as follows. Wealth enables additional consumption of goods and services. An agent with a high level of wealth is able to demand more services from other agents. The agent has economic power. The greater the discrepancy in wealth, the more services an individual can purchase. If consumption is a signal of wealth, then maintaining comparative consumption is a signal of one's economic power and social status. Utility in this case is not derived from the consumption of the service, but from the status of being powerful.

However, habit may not be modelled preferences at all. Campbell and Cochrane (1995) argue that habit could be capturing the effects of idiosyncratic income variation, debt with incomplete markets or a stop-loss rule where risk aversion increases as stock begins to fall. Another possibility is the effect of small and information poor investors known as noise traders. Kelly (1997) and Mankiw and Zeldes (1991) suggest that noise traders enter the market in times of high volatility. Henry (1998) shows that the asymmetry in stock returns are biased towards making losses only when volatility is high – hence small investors are more likely to lose their money. For their belief exposure to the stock market they conclude that equity is an unwise investment, and return to investing in risk free assets. Aggregation ignores agent distinctions, and hence the upward bias in the aggregated risk aversion coefficient.

One part of the study presented here does not attempt to distinguish the reasons for including habit. The purpose is to show that habit utility has empirical support outside the U.S. It presents a habit formulation and tests it using Australian data to find whether the high relative risk aversion is the result of preference specification and not market frictions, noise traders or aggregations problems.

Mankiw and Zeldes (1991) point out an empirical problem in the derivation of the equity premium. They suggest that the equity premium puzzle may result from the differences in the consumption data of stockholders and non-stockholders. They find almost 75% of the population does not hold stocks excluding pension accounts. For this, the aggregate consumption does not make a good variable for the representative investor's consumption in the model. With the aggregate consumption of stockholders, they find that their consumption is three times more sensitive to stock market fluctuations than that found in the aggregate consumption data of all the population which was used in the Mehra and Prescott (1985). This means that the higher rate of return for equity could be derived from the model which helps to explain the equity premium. But even after making these adjustments, the level of risk aversion parameter, γ, needed to explain the equity premium is in the neighbourhood of 10 which is still quite high.

A group of other economists have modified the utility function by making the utility of consumption depend on a comparison between current consumption and some base or bench mark level. If the benchmark is taken to be prior level of consumption, then the behaviour can be described as 'habit formation', as first suggested by Duesenberry (1952).

Constantinides (1990) finds that habit formation has the effect of making the representative investor more sensitive to short-run reductions in consumption in the context of the basic asset pricing model. This implies that the representative investor has a high short-run risk aversion but a relatively lower long-run risk aversion. However, Ferson and Constatinides (1991) discuss that the habit formation approach (model) cannot explain the difference in returns between equity and bonds.

Concerned with the habit formation utility behaviour, another possible benchmark consumption with which current consumption can be compared is the consumption levels of others in the economy. An investor who is interested in other's consumption patterns could get utility not just from his/her own consumption but from knowing that he/she is consuming more than others. Conversely, if others become better off and the investor does not, the investor could be miserable. Abel (1990) examines an asset pricing model where agents have this type of utility functions, which he named as "catching up with the Joneses."

A similar approach has been taken by Campbell and Cochrane (1999). In contrast with Able's model, they however assume that the utility is derived from the difference between consumption and habit level unlike the ratio between the two consumption level modelled in Abel (1990). They assume that the external habit take an AR(1) process which moves slowly and they insert it into the habit formation utility to simulate a higher equity premium and better stochastic properties for stocks and bonds.

Rietz (1988) advances the view that the excessive returns on stocks incorporate the probability of a disaster-like event, which can drastically impact on the agent's consumption. Mehra and Prescott (1988) respond to Rietz's (1988) analysis by saying that historically a huge drop in consumption has never occurred even during the Crash of 1929 and the ensuing Great Depression.[10]Kandel and Stambaugh (1990) and Cecchetti et al. (1993) present a Markov-switching model in which they incorporate periods of good years and period of bad years with unpredictable switches between the two. They still come up with an unreasonable value of risk aversion to explain the equity premium puzzle.

[10] Salyer (1998) reviews Rietz's model of the 'crash-state economy' and finds that it can explain the mean - equity premium. However, it dramatically under-predicts its volatility.

Benninga and Protopapadakis (1990), along with the above researchers, model stock returns as leveraged claims on firms. Here too, these scholars determine a high value of risk aversion to justify the equity premium puzzle.

Mankiw and Zeldes (1991) and Haliassos and Bertaut (1995) suggest that the market for stocks is segmented with only 30% of individuals in the US economy owning them directly or through defined contribution plans. They too cannot explain the equity premium puzzle as they determine that level of risk aversion to be high (in the proximity of 10).

In this chapter we have seen some of the problems encountered when trying to derive the equity premium. The literature convered here doesn't do justice to what is presently being done. There are other empirical avenues where equity premium is derived using stochastic discount factor models, dividend yield measures, size effects under the umbrella of Fama and French studies.

A Closer Look at the CCAPM

The derivation of the CCAPM requires the assumption of homoskedastic lognormal returns. In a homoskedastic lognormal setting, the consumption-wealth ratio is shown to depend on the elasticity of intertemporal substitution in consumption, while asset risk premia are determined by the coefficient of relative risk aversion. Log normality accounts for asymmetry in stock returns, homoskedasticity assumes there are no GARCH effects[11]. Both

[11] Since we are using quarterly observations we actually tested for GARCH effects using a GARCH (1,1) model and found that there were none.

these assumptions are empirically and theoretically unrealistic Henry (1998). Notwithstanding this, the assumption is retained to get an estimable derivation.

Note that in all equations small letters are the natural logarithmic transformation of the capital letter counterpart. For example

$$\log_e X = x$$

Representative Agents

By using the external habit function in the tradition of Abel (1990), a representative agent assumption is required. Abel's justification for a representative agent is that agents form habit based on the level of consumption of peers. The agent derives utility from his position relative to aggregate consumption, and tries to catch up with it. The representative agent assumption simplifies the model. In particular it means that the stochastic discount factor is the intertemporal marginal rate of substitution, which makes deriving Arrow-Debreu securities easier[12]. The risk premium on an asset can be negative when the asset provides better payoffs in bad states. "Bad" states are bad because most of the assets provide lower payoffs than usual, and cash is especially needed. The stochatic discount factor ("price per unit of probability") is high in these states. A further pragmatic reason is that data collection is simplified. However, it is important to realise the representative agent carries both implicit and explicit assumptions.

[12] The difference between complete and incomplete market is used to explain an Arrow-Debrew type security. In a complete market you can replicate any security with the set of some basic securities. In other words, it is possible to construct and trade an Arrow-Debrew security for each state. In an incomplete market Arrow-Debrew securities for some states cannot be traded and replicated.

Explicitly, a representative agent can only represent economies with complete markets and with agents who face identical prices. Mehra and Prescott (1985) suggest that the U.S. economy is not in Arrow-Debreu equilibrium and that this causes the equity premium puzzle. This study rejects their hypothesis, and finds that the equity premium can be explained by retaining the assumption of complete markets.

An implicit assumption of the representative agent is the lack of human interaction. It implies that agents are individuals who make no difference to one another. Behaviourists suggest that human interaction is perhaps more significant than consumption. Contrary to notion that the common end of all individuals is the '[pursuit] of the production of means of life' Hunt (1950, p37), the common end may be an acceptance by one's peers. It requires that it is not sufficient for the individual to interact with the firm – he should also interact with society. An easy way to include this, and maintain the representative agent model, is to use recursive (habit) utility functions that makes intertemporal comparisons. The representative agent assumption can incorporate agent to agent interaction if the utility is designed in such a way that the representative interacts with himself. Intuitively, the agent consumes based on consumption patterns in the past. These previous consumption patterns can be viewed as the agent's peers if the lags are not too long. The individual has habit because his best prediction of his peers consumption is past aggregate consumption and he does not wish consumption to fall below that of his peers. In this way the study removes the implicit assumption of no human interaction. Consequently, habit is a more realistic model of human interactions than CRRA preferences.

The representative agent problem creates the related issue of aggregation. Campbell and Cochrane (1995) recognise the importance of allowing for aggregation.

'Aggregation is another important question that we do not address. ...it can be defended as a model of the social welfare function of an economy of agents with unknown preference, as the utility of a marginal investor who consumes aggregate consumption and holds the market portfolio, or by the assumption of identical agents. But it is important to study aggregation... if one wishes to draw lessons from asset markets for the preference that one uses in micro data' (Campbell and Cochrane 1999, p45).

Weil (1989) suggests that aggregation is one reason for the equity premium puzzle. If preferences are heterogenous, and individual consumption is more risky than aggregate consumption, then the aggregate coefficient of risk aversion will be high even if individuals are only moderately risk averse. This study maintains the aggregate assumption and resolves the equity premium puzzle using habit preference specifications.

One of the benefits of using CRRA utility is that the aggregation of CRRA functions is another CRRA utility function, with the coefficient of risk aversion equal to the harmonic mean of the individual functions. This property holds for the encompassing habit utility function as well.

Deriving CCAPM Identities

Static pricing models such as arbitrage pricing theory (APT) and the capital asset pricing model (CAPM) ignore consumption decisions. Instead agents are assumed to maximise returns and minimise risk. The models are static in the sense that all consumption choices are made in one period and only allow state contingent choices. The CCAPM can allow for intertemporal as well as multiple state choices. However, with CRRA utility though, these concepts are linked too closely.

Identity 1

The agent's problem is to maximise lifetime utility

$$Max\, E_t\left[\sum_{j=0}^{\infty}\delta^j U(C_{t+j})\right] \qquad (3.2.1)$$

If the return on holding an asset i until $t+1$ is R_{t+1} then the agent maximises 3.2.1 subject to

$$C_{t+1} = (1+R_{t+1})C_t$$

The Euler Equation for lifetime utility maximisation is then

$$U'(C_t) = \delta E_t\left[(1+R_{i,t+1})U'(C_{t+1})\right] \qquad (3.2.2)$$

which simplifies to

$$1 = E_t\left[(1+R_{t,t+1})\frac{\delta U'(C_{t+1})}{U'(C_t)}\right]$$

$$\therefore 1 = E_t\left[(1+R_{i,t+1})M_{t+1}\right] \qquad \text{(IDENTITY 1)}$$

IDENTITY 1 is the basic equation of the CCAPM. M_{t+1} is the price of an Arrow-Debreu security (or the stochastic discount factor). In the above derivation it is equivalent to the intertemporal marginal rate of substitution because of the representative agent assumption. The price of an Arrow-Debreu security rises if consumption falls because the agents marginal utility has risen and so the demand for an entitlement for extra consumption. If shares are considered to be a form of long-term bonds then M_t can represent the market portfolio.

Identity 2

Taking the unconditional expectation of equation 1.3 gives

$$1 = E\left[(1 + R_{i,t})M_t\right]$$

Expanding the unconditional expectation of two stochastic variables leaves

$$1 = \mathrm{E}\left[1 + \mathrm{R}_{i,t}\right] \times E\left[M_t\right] + Cov\left[(1 + R_{i,t}), M_t\right]$$

$$\therefore E\left[1 + R_{i,t}\right] = \frac{1}{E\left[M_t\right]}\left\{1 - Cov\left[(1 + R_{i,t}), M_t\right]\right\}$$

IDENTITY 2 is the unconditional expected return on an asset i. It shows that the return on an asset increases as the Arrow-Debreu security price falls, and decrease as the correlation between the return and the Arrow-Debreu security price increase.

Identity 3

A riskless asset *f* return will be uncorrelated with M_t because the payout occurs despite the state of the world. This is the same argument as the zero-beta asset of the standard CAPM. Consequently, for a riskless asset, the return R_f is

$$E\left[1 + R_{ft}\right] = \frac{1}{E\left[M_t\right]} \qquad \text{(IDENTITY 3)}$$

Identity 4

The excess of the expected return from risky asset (IDENTITY 2) over the return of a riskless asset (IDENTITY 3) is the risk premium.

$$E[1+R_{i,t}]-E[1+R_{i,t}]=\frac{1}{E[M_t]}\{1-Cov[(1+R_{i,t}),M_t]\}-\frac{1}{E[M_t]}$$

$$\therefore E[R_{i,t}-R_{ft}]=\frac{1}{E[M_t]}Cov[(1+R_{i,t}),M_t]$$

Then substituting in IDENTITY 3 again,

$$E[R_{i,t}-R_{ft}]=-E[1+R_{ft}]\times Cov[(1+R_{i,t}),M_t \qquad \text{(IDENTITY 4)}$$

The risk premium (IDENTITY 4) explains the intuition behind investment choices and required returns. The equity premium is higher when the covariance between the asset i return and the price of an Arrow-Debreu security is small. Indeed, there is only an excess return if the covariance is negative. Arrow-Debreu securities are the ratio of marginal utilities. When Arrow-Debreu prices decreases, the marginal utility of consumption today is smaller than the marginal utility in the next period for a constant discount rate δ. If the utility function is constant, then expected marginal utility will rise only if consumption is expected to fall. Consequently, the agent tries to shift consumption into the next period by investing in asset i. However, if asset i is positively correlated with the Arrow-Debreu security then the return on the asset must fall and the payout in the next period is low. As Campbell (1999) writes

'Such as asset is risky in that it fails to deliver wealth precisely when wealth is most valuable to the investor.' pp294

The agent will only hold the asset if it attracts a large risk premium. The CCAPM IDENTITY 1 shows that the return from equity assets can be derived from Arrow-Debreu securities, which are in turn derived from the consumption choice. It is the link between consumption and asset returns on which the CCAPM is based.

The Coefficient of Relative Risk Aversion

Actuarially fair insurance price is a condition for Arrow-Debreu equilibrium. It is also a necessary condition for the life cycle-permanent income hypothesis (Modigliani and Brumberg 1954, Friedman 1957). It requires that the expected marginal rate of interstate substitution must equal the relative price of consumption in each state (Equation 3.3.1). This ensures that agents do not pay any more than the expected marginal utility from each state. From any other price ratio insurance will be less than complete, and consumption titled to the contingent state where insurance is relatively cheaper. As no insurance is required for current consumption, consumption is shifted away from future periods. The implication is that in an uncertain world, consumption may not be spread evenly across lifetimes if actuarially fair insurance is unavailable. Ricardian equivalence relies on a similar perfect foresight / risk-free mechanism. If people shift consumption to the present, then clearly Ricardian equivalence cannot hold.

$$\frac{\pi^a u'(C_2^a)}{\pi^b u'(C_2^b)} = \frac{P^a}{P^b} \qquad (3.3.1)$$

Taking the natural logarithm of Eq. 3.3.1 and then totally differentiating the price ratio.

$$\log\left(\frac{P^a}{P^b}\right) = \log\left(\frac{\pi^a u'(C_2^a)}{\pi^b u'(C_2^b)}\right)$$

$$\therefore d\log\left(\frac{P^a}{P^b}\right) = \frac{u''(C^a)}{u'(C^a)}dC^a - \frac{u''(C^b)}{u'(C^b)}dC^b$$

$$\therefore d\log\left(\frac{P^a}{P^b}\right) = \frac{C^a u''(C^a)}{u'(C^a)}d\log C^a - \frac{C^b u''(C^b)}{u'(C^b)}d\log C^b$$

$$d\log\left(\frac{P^a}{P^b}\right) = \gamma d\log C^a - \gamma d\log C^b$$

$$\therefore \frac{1}{\gamma}d\log\left(\frac{P^a}{P^b}\right) = d\log C^a - d\log C^b$$

$$\therefore \frac{1}{\gamma}d\log\left(\frac{P^a}{P^b}\right) = d\frac{\log C^a}{d\log C^b}$$

$$\therefore d\log\left[\frac{C^a}{C^b}\right] = \frac{1}{\gamma}d\log\left(\frac{P^a}{P^b}\right) \qquad (3.3.2)$$

$$Note\ \gamma^i = -\frac{C^i u''(C^i)}{u'(C^i)} \qquad (3.3.3)$$

Equation 3.3.2 can explain the coefficient of relative risk aversion. γ gives the convexity of the utility function and is the Arrow-Pratt relative risk aversion coefficient. γ^i can be simplified to a constant γ if it is assumed to be independent of wealth and hence constant of all consumption levels. Note that coefficients of a log-log equation are elasticities. Hence, equation 3.3.2 shows that the risk aversion coefficient may be interpreted as the elasticity of substitution between consumption in different states of the world and the relative Arrow-

Debreu prices. A high risk aversion results in inelastic price demand for consumption insurance. This coefficient represents the degree of strict preference of a finite value to the expected value of a gamble. Friend and Blume (1975) suggest that γ should not exceed 10, giving the minimum price elasticity of insurance demand as 0.1.

Equation 3.3.2 shows that the coefficient of risk aversion (γ) is completely unrelated to intertemporal choice. It is the choice between states of the world that matter. It is not unreasonable to assume that the future is uncertain, but it is unreasonable to assume that risk aversion is the only consideration when making intertemporal choice and vice versa. For example, the riskless rate is completely independent of risk but will definitely affect intertemporal choice. Similarly, it is possible to imagine an investor faced with the choice between risky assets set to mature at the same date. Under these circumstances intertemporal choice has no relation to the asset chosen. The inseparability of risk aversion and intertemporal choice is a major problem of CRRA utility for describing portfolio allocation. In the next section (3.4) CRRA utility is shown to be unable to make the risk/time distinction, and hence is flawed.

The simplifying assumption that removed wealth effects to allow the relative risk aversion coefficient constant to be constant has important implications. It implies that preferences do not change in the different states of the world. That is, the utility function is unchanged despite which state is realised. This is unrealistic, an unexpected income shock will change preferences for luxury, normal and giffen goods. In fact preferences are likely to change in any circumstances whereby human emotions change – this includes small day to day changes right up to generation gaps. The assumption of a fixed utility function is slightly relaxed by including habit utility. With habit utility time varying risk aversion can be incorporated and so the zero wealth effects assumption can be discarded. This is another benefit of habit utility over CRRA.

The CRRA Time Separability Problem

The CRRA utility function is specified below.

$$U(C_t) = \begin{Bmatrix} \dfrac{C_t^{1-\gamma}}{1-\gamma}\, when\, \gamma \neq 1 \\ \log(C_t)\, when\, \gamma = 1 \end{Bmatrix} \qquad (3.4.1)$$

γ is the coefficient of risk aversion as discussed previously.

Beginning with CCAPM IDENTITY 1, reproduced below

$1 = E_t[(1 + R_{i,t+1})M_{t+1}]$

substituting in the derivative of the CRRA utility function

$$1 = \mathrm{E}_t[(1 + R_{i,t+1})\delta \frac{C_{t+1}^{-\gamma}}{C_t^{-\gamma}}]$$

$$\therefore 1 = E_t[(1 + R_{i,t+1})\delta (\frac{C_{t+1}}{C_t})^{-\gamma}]$$

Take the natural log of the CRRA CCAPM and using the assumption of lognormal, homoskedastic returns

$$\log 1 = \log\{E_t[(1+R_{i,t+1})\delta(\frac{C_{t+1}}{C_t})^{-\gamma}]\}$$

$$\therefore 0 = E_t[\log\{(1+R_{i,t+1})\delta(\frac{C_{t+1}}{C_t})^{-\gamma}\}] + \frac{1}{2}\mathrm{var}[\log\{(1+R_{i,t+1})\delta(\frac{C_{t+1}}{C_t})^{-\gamma} - E_t[\log\{(1+R_{i,t+1})\delta(\frac{C_{t+1}}{C_t})^{-\gamma}\}]]$$

if R is small enough then log(1+R) = R

$$\therefore 0 = E_t[R_{i,t+1}] + \log\delta + E_t\log\{(\frac{C_{t+1}}{C_t})^{-\gamma}\} + \frac{1}{2}\mathrm{var}\left\{R_{i,t+1} + \log\delta + \log\{\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\} - E_t[R_{i,t+1}]R - \log\delta - \log\{\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\}\right\}$$

$$\therefore 0 = E_t[R_{i,t+1}] + \log\delta - \gamma E_t[c_{t+1} - c_t] + \frac{1}{2}[\mathrm{var}(i) + \gamma^2\,\mathrm{var}(c) - 2\gamma\,\mathrm{cov}(i,c)]$$

$$\therefore 0 = E_t[R_{i,t+1}] + \log\delta - \gamma E_t[g_{t+1}] + \frac{1}{2}[\sigma^2 + \gamma^2\sigma_c^2 - 2\gamma\sigma_{ic}] \qquad (3.4.2)$$

where g_t is the growth rate of consumption. This equation (3.4.2) can be used to derive an expression for the riskless interest rate. A riskless interest rate will be uncorrelated with consumption and have a zero variance.

$$0 = E_t[R_{i,t+1}] + \log\delta - \gamma E_t[g_{t+1}] + \frac{\gamma^2\sigma_c^2}{2}$$

$$\therefore E_t[R_{i,t+1}] = \gamma E_t[g_{t+1}] - \log\delta - \frac{\gamma^2\sigma_c^2}{2}$$

$$\therefore R_{i,t+1} = \gamma g_{t+1} - \log\delta - \frac{\gamma^2\sigma_c^2}{2} \qquad (3.4.3)$$

The risk free equation (3.4.3) can be rearranged to get an expression for consumption growth as a function of the risk-free rate.

$$g_{t+1} = \frac{1}{\gamma}E_t R_{f,t+1} + \frac{\log\gamma}{\gamma} + \frac{\gamma\sigma_c^2}{2} \qquad (3.4.4)$$

The coefficient of the log function 3.4.4 gives the elasticity of consumption to changes in the risk free rate. This elasticity is also know as the elasticity of intertemporal substitution, ψ. Hence the separability problem of CRRA utility. The relationship between the elasticity of substitution, ψ, is the reciprocal of the coefficient of risk aversion.

$$\psi = \frac{1}{\gamma} \qquad (3.4.5)$$

It has been shown in section 3.3 that such a close relationship does not make sense.

The CRRA Risk Free Rate Puzzle

For CRRA the risk-free rate equation (3.4.3) shows that the risk-free rate is a linear function of consumption growth with a gradient of γ. The risk-free rate is high if consumption growth is high because the agent will try to borrow more to spread out lifetime consumption. The second term shows that it will also be high if the discount rate δ, is low. The last term is a precautionary savings term. It shows that the risk-free rate increases with decreasing consumption volatility, weighted by the square of coefficient of risk aversion. If γ is high, and g is positive, then a low risk-free rate can only exist if the time preference, δ, is greater than one, requiring a negative time preference. For Australian data $\overline{r_f} = 0.89\%, \overline{g} = 0.47\%, \sigma_c = 0.35\% \, and \, \gamma = 19$. Hence, δ = 1.08 which implies a negative time preference. Imposing the restriction δ = 1.00, the mean riskless rate is 8.7%, which is far too high. This is the related risk free rate puzzle.

The CRRA Equity Premium Puzzle

In this section the equity premium equation is derived to demonstrate the effect of the separability problem.

Subtracting the risk free rate (Equation 3.4.3) from the risky rate (Equation 3.4.2) gives the equation for the CRRA equity premium which is stated below (Equation 3.4.6)

$$E_t[R_{i,t+1}] - E_t[R_{f,t+1}] = -\log\delta + \gamma E_t[g_{t+1}] - \frac{1}{2}[\sigma_{ic}^2 + \gamma^2\sigma_c^2 - 2\gamma\sigma_{ic}]$$
$$-\{-\log\delta + \gamma E_t[g_{t+1}] - \frac{\gamma^2\sigma_c^2}{2}\}$$

$$\therefore E_t[R_{i,t+1} - R_{f,t+1}] = \gamma\sigma_{ic} - \frac{\sigma_i^2}{2} \qquad (3.4.6)$$

The assumption of homoskedasticity means that the variance and covariance terms are constant. Hence, changes in the equity premium can only be caused by changes in the coefficient of relative risk aversion. There must be a time varying coefficient of risk aversion if the equity premium is volatile but CRRA utility can not allow for it. Mehra and Prescott (1985) use equation (3.4.6) and estimate the coefficient of relative risk aversion to be 25 for U.S. equity. Using Australian data this study found that γ = 19. This is significantly greater than Friend and Blume's acceptable maximum of 10.

The CRRA Volatility of Consumption

The problem of CRRA utility can be viewed another way by showing its prediction for stock volatility. Hansen-Jagannathan bounds show that the lower bound of the standard deviation of Arrow-Debreu assets with a mean of one is given by

$$\sigma_{M_t} = \frac{E[r_{it} - r_{ft}]}{\sigma_{r_{it} - r_{ft}}} \qquad (3.4.7)$$

To undersand the Hansen-Jagannathan bounds we start with the following fundamental equation representative of most asset pricing models.

$$E(m_t R_t | Z_{t-1}) = e \qquad (3.4.8)$$

where R is a vector of gross (unity plus rate of) returns on traded assets, Z_{t-1} is a vector of instruments in the public information set at time t-1 and e is vector of ones. The standard asset pricing models in finance specify the form of a random variable, m_t, the stochastic discount factor (see review by Ferson, 1995). The elements of the vector $m_t R_t$ my be viewed as "risk adjusted" gross returns. The returns are risk adjusted by "discounting " them, or multiplying by m_t, to arrive at the "present value" per dollar invested, equal to one dollar. A stochastic discount factor is said to "price" the assets R if Equation (3.4.8) is satisfied.

Hansen and Jagannathan (1991) derive lower bounds for the variance of any stochastic discount factor which satisfies the fundamental valuation Equation (3.4.8); such bounds may be used as a prior diagnostic. If a candidate for m_t, corresponding to a particular theory, fails to satisfy the Hansen Jangannathan bounds, then it cannot satisfy the Equation (3.4.8).

To calculated the Hansen Jaganaathan bounds we first consider the special case where the conditioning information is a constant, so the expectations in (3.4.8) are unconditional. Assume that the random colmun n-vector R of the assets gross returns has mean $E(R) = \mu$ and covariance matrix Ω. When there is no conditionning information a stochastic discount factor is defined as any random variable m such that $E(mR) = e$.

Proposition 1 (Hansen and Jagannathan, 1991). The stochastic discount factor m with minimum variance for its expectation E(m) is given by

$$m = E(m) + [e - E(m)\mu]'\Omega^{-1}(R - \mu) \qquad (3.4.9)$$

And the variance of m is

$$\sigma_m^2 = [e - E(m)\mu]'\Omega^{-1}[e - E(m)\mu] \qquad (3.4.10)$$

The proof is provided in Hansen and Jagannathan (1991).

Hansen and Jagannathan (1991) show that their lower bound is related to the maximum Sharpe ratio that can be obtained by a portfolio of the assets under consideration. The Sharpe ratio is defined as the ratio of the expected excess return to the standard deviation of the portfolio return. If the vector of assets expected excess returns is $[\mu - E(m)^{-1}e]'\Omega^{-1}[\mu - E(m)^{-1}e]$. Thus, from Equation (3.4.10) the lower bound on the variance of stochastic discount factors is the maximum squared Sharpe ratio multiplied by $[E(m)]^2$.

The conventional CCAPM with reasonable levels of risk aversion (<10) can give a mean of one, but the implied Arrow-Debreu asset is less volatile than the Hansen- Jagannathan lower volatility bound. The implied lower bound for the standard deviation of the Arrow-Debreu asset using Australian quarterly data is 0.22. The mean of the Arrow-Debreu asset using CRRA utility is one, but the standard deviation is 0.12, much less than the minimum value of 0.22. This anomaly is part of the equity premium puzzle. Either returns are too volatile or consumption is too smooth.

Chapter 4

The Habit Model of Campbell and Cochrane

To generate time-varying expected returns, the model economy adds habit persistence to the standard consumption-based specification. As bad shocks drive consumption down towards the habit level, risk aversion rises, stock prices decline, and expected returns rise. Campbell and Cochrane(1999) describe the model in detail, and motivate the ingredients.

Consumption growth is an i.i.d. lognormal endowment process, where it is assumed that consumption is a random walk with drift.

$$
\begin{aligned}
& c_{t+1} = c_t + g + u_{t+1} \\
& \therefore c_{t+1} - c_t = g + u_{t+1} \\
& \therefore \Delta c_{t+1} = g + u_{t+1}
\end{aligned}
\qquad (4.0.1)
$$

Consequently, consumption growth, g, is constant.

The surplus consumption ratio, S_t, is specified as the excess of consumption over the level of habit, X_t.

$$S_t = \frac{C_t - X_t}{C_t} \qquad (4.0.2)$$

Zero surplus habit consumption is the limit at which utility reaches zero. The agent only values the consumption in excess of habit and S_t will approach zero in bad times. The agent will still try to spread utility out across his lifetime and expects consumption to grow. An expectation of future higher consumption means that habit will grow. This is one way by which the model still incorporates rational expectations. As an aside this means that utility may never increase over the long run – the agent subsists at a constant level, forever trying to stay afloat.

Habit is modeled as an AR (1) process. Habit implies persistence, which in turn implies that the surplus consumption ratio should contain a unit root. Ruling out myopia, changes in habit should be close to permanent. Consequently, the log surplus consumption ratio, s_t, is specified as an AR (1) process with ϕ close one.

$$S_{t+1} = \phi S_t + \varepsilon_{t+1} \qquad (4.0.3)$$

Hence, a fully informed agent will maintain a constant surplus consumption ratio. If $\phi \neq 1$ then the surplus consumption ratio would revert to zero $(\phi < 1)$, or explode to infinity $(\phi > 1)$. Under these specifications habit would not exist. Myopia would allow for $\phi < 1$ as long as the reversion is slow enough to be considered realistic. ϕ controls the persistence of changes in the surplus ratio. It has already been noted that because consumption is a random walk and habit is persistent, ϕ should be one. However, Hall (1978) finds that changes in stock price have a predictive power in forecasting consumption. This is the main sense by which rational expectations are incorporated. Fama and French (1988) show that a rational investor can use the price dividend ratio to make forecasts about future returns. Although transaction costs rule out price dividend ratios for arbitrage, they will still give an indication of future returns and hence consumption timing. If future consumption can be forecasted, then rational habit should reflect this ability. Consequently, ϕ is the autocorrelation coefficient from price dividend ratios.

The error terms from 4.0.1 and 4.0.2 are not the same $\varepsilon_{t+1} \neq (c_{t+1} - c_t - g)$. Consequently the unit root in habit does not imply consumption shocks permanently affect habit in a one for one ratio. The two errors are related using a sensitivity function. By including the sensitivity function $\lambda(s_t)$, shocks to consumption can be dampened before they impact upon habit. It controls how the surplus consumption can be dampened before they impact upon habit. It controls how the surplus consumption ratio should respond to shocks in the growth rate of consumption, μ_{t+1}. Campbell and Cochrane specify three criteria for the sensitivity function.

1) Habit must change so that consumption is never permanently below habit. It would not make sense for habit to be consistently above consumption if consumption was not expected to grow in the future.

2) Habit must not move for unit with consumption. Perfect correlation would mean that the surplus consumption ratio was constant. This would revoke the characteristics of habit consumption – intertemporal changes in marginal utility and time varying risk premium.

3) Habit must be positively correlated with consumption so that habit always increases with rising consumption.

Incorporating these criteria, the sensitivity function is specified as

$$\lambda(s) = \begin{cases} \frac{1}{s}\sqrt{1/2(s-\bar{s})/1} \\ 0 \text{ if square root is negative} \end{cases} \qquad (4.0.4)$$

Based on this, the habit model is

$$s_{t+1} = (1-\phi)\bar{s} + \phi s_t + \lambda(s_t)\mu_{t+1} \qquad (4.0.5)$$

$\bar{s}$ is the steady state surplus consumption ratio or the unconditional expectation of the surplus consumption ratio.

Campbell and Cochrane state that the criteria for the sensitivity function imply that in steady state, restriction (4.0.6) must hold

$$\bar{S} = \sigma\sqrt{\frac{\eta}{1-\phi}} \qquad (4.0.6)$$

where η is the curvature parameter of the utility function.

Having derived a specification for habit, the utility function is expressed. It is based on the time separable utility function, but instead agents obtain utility from surplus consumption rather than the level of consumption.

$$U(t) = E_t\left[\sum_{j=0}^{\infty} \delta^j \frac{C_t \quad X_t)^{1 \ \eta} \quad 1}{1/\eta}\right] \qquad (4.0.7)$$

δ - subjective discount factor
η - curvature parameter (note this is not the risk aversion coefficient)

Substituting the first and second derivatives of utility with respect to consumption into the coefficient of relative risk aversion (3.3.3) gives

$$\gamma = \frac{\eta}{S} \qquad (4.0.8)$$

Which is time varying if S varies. It has been established from 3.3 that a time varying risk aversion coefficient is desirable. Risk aversion increases as S declines. As consumption approaches habit, agents become more risk averse. Intuitively this can explain some of the risk aversion anomalies since agents are often more prepared to take gambles that decrease discounted future income, rather than equivalent gambles that decrease income today.

CCAMP IDENTITY 2 is used to derive the habit CCAMP

$$M_{t+1} = \delta \frac{u'(C_{t+1})}{u'(C_t)}$$

and the marginal utility of consumption is

$$u'(C_t) = (C_t - X_t)^{-\eta}$$
$$\therefore u'(C_t) = [\frac{C_t}{C_t}(C_t - X_t)]^{-\eta}$$
$$\therefore u'(C_t) = [C_t S_t]^{-\eta}$$
$$\therefore u'(C_t) = C_t^{-\eta} S_t^{-\eta}$$

so the Arrow - Debreu price series is

$$\mathrm{M}_{t+1} = \delta [\frac{C_{t+1}{}^{-\eta} S_{t+1}{}^{-\eta}}{C_t{}^{-\eta} S_t{}^{-\eta}}]^{-\eta} \qquad (4.0.9)$$

Note that the volatility of the Arrow-Debreu prices now depend on the surplus habit ratio as well as η. This confirms the habit relative risk aversion coefficient, which included surplus consumption term S. It is straightforward to derive an expression for the risk free rate using CCAPM IDENTITY 2, reproduced below.

$$1 + R_f = \frac{1}{E_t[M_{t+1}]}$$

taking logs and using the property that log (1+x) = x when x is small

$$\log(1+R_f)=\log\frac{1}{E_t[M_{t+1}]}$$

$$\therefore R_f=\log{}^{1}\!/\!_{\delta}\left[\frac{C_t}{C_{t+1}}\frac{S_t}{S_{t+1}}\right]^{-\eta}$$

$$\therefore R_f=-\log\delta-\eta\log\left[\frac{C_{t+1}}{C_t}\right]-\eta\log\left[\frac{S_{t+1}}{S_t}\right]$$

$$\therefore R_f=-\log\delta+\eta g-\eta[s_{t+1}-s_t]$$

substituting in equation 4.0.5 for s_{t+1} leaves

$$R_f=-\log\delta+\eta g-\eta[(1-\theta)\bar{s}+\theta s_t+\lambda(s_t)\mu_{t+1}-s_t]$$

$$\therefore R_f=-\log\delta+\eta g-\eta[(1-\theta)\bar{s}+(\theta-1)s_t+\lambda(s_t)\mu_{t+1}]$$

$$\therefore R_f=-\log\delta+\eta g-\eta[(1-\theta)\bar{s}-(1-\theta)s_t+\lambda(s_t)\mu_{t+1}]$$

$$\therefore R_f=-\log\delta+\eta g-\eta[(1-\theta)(\bar{s}-s_t)+\lambda(s_t)\mu_{t+1}]$$

$$R_f=-\log\delta+\eta g-\eta(1-\theta)(s_t-\bar{s})-\frac{\eta^2\sigma_g^2}{2}[\lambda(s_t)+1]^2 \qquad (4.0.10)$$

Note the similarity between this equation and the risk-free rate of the CRRA risk free equation (3.4.3). The third term is like an error correction term. If describes how the interest rate changes as the surplus consumption rate moves away from the steady state (mean) consumption ratio. If the surplus consumption ratio is high, then marginal utility today is low. If the agent expects the ratio to return to the steady state then marginal utility today is low. If the agent expects the ratio to return to the steady state then marginal utility will increase in the future. The agent tries to shift consumption into the next period by saving, which lowers the interest rate. If is a mean-reversion in marginal utility term and it is not included in the CRRA equation.

The fourth term is a precautionary saving term in the same way as the CRRA model, but it includes the sensitivity function as well. Hence, the volatility of the risk can be controlled.

The habit specification has also increased the separation of the elasticity of intertemporal substitution from the coefficient of risk aversion which is a clear advantage over the other models. Rearranging the risk free equation (4.0.10) leaves the following expression.

$$\therefore g = \frac{1}{\eta}\log\delta + R_f + \eta(1-\theta)(s_t - \bar{s}) + \frac{\eta^2\sigma_g^2}{2}[\lambda(s_t)+1]^2$$

So the intertemporal substitution is $\varphi = \frac{1}{\eta} = \frac{1}{\gamma S}$. Changes in intertemporal substitution do not have to impact on relative risk aversion. They can impact on the surplus habit ratio instead.

Chapter 5

Estimating the Model

To test the habit model an estimation of the equity premium was performed. It was expected to compare favourably with actual series if the model could correctly predict returns. First a series of implied habit was generated, then the risk free rate, and finally the equity premium was forecasted.

Making the series S_t

To make a static series of S_t it was assumed that investors are rational and make revisions to the short run steady state surplus consumption ratio so that the actual surplus consumption ratio is the steady state consumption ratio. It may seem to be a case of forecasting habit by first removing agents inclination to follow habit. However, the preference for habit is incorporated by the parameters ϕ and η. In addition, one the series of steady state habits was obtained, a one period ahead forecast of S_{t+1} was produced by reintroducing habit. It was this series that was used to estimate the risk free rate. The steady state consumption ratio is given by

$$\overline{S} = \sigma_g \sqrt{\frac{\eta}{1-\phi}} \qquad (4.0.6)$$

using the assumption of short run steady state revision gives

$$S_t = \sigma_{gt}\sqrt{\frac{\eta}{1-\phi}} \qquad (5.0.1)$$

In the long run the steady state consumption ratio $\bar{S}$ will still be given by equation 4.0.6 and this should be the same as the mean of the series S_t generated by equation 4.0.12.

The conditional standard deviation of consumption growth was obtained by running a GARCH (p, q) model. ϕ was estimated by running an ARMA model on price dividend ratios and using the AR(1) coefficient. The curvature parameter η was more difficult to estimate. Campbell and Cochrane use the Hansen-Jagannathan lower volatility equation (3.4.6) restated below.

$$\frac{\sigma_{M,(\bar{M})}}{\bar{M}} = \frac{E(r_{it} - r_{ft})}{\sigma_{r_{it}-r_{ft}}}$$

where $\bar{M}$ is the unconditional expectation of the Arrow-Debreu asset.

By taking the unconditional expectation of $\bar{M}$ there is an assumption that the risk free interest rate is constant in the long run. Nonetheless, Campbell and Cochrane's method was followed. $\bar{M}$ can be estimated by using CCAPM IDENTITY 2

$$1 + R_f = \frac{1}{E_t[M_{t+1}]}$$

hence,

$$\overline{M} = \frac{\sum_{t=1}^{n} \frac{1}{1 + R_{ft}}}{n}$$

Then by trying different values of η in the habit utility function a series of M_t could have been generated until the Hansen-Jagannathan equality holds. The table from Campbell and Cochrane (1995) showing values of η that are consistent with the Hansen-Jagannathan lower bound is reproduced below.

Table – Curvature Parameter and the Hansen-Jagannathan Lower Volatility Bound

η	$E\left[\frac{r - r_f}{\sigma_{r-r_f}}\right]$
1	0.14
2	0.19
2.5	0.22
3	0.25
4	0.30
5	0.34

Note that Hansen-Jagannathan lower volatility bound is insensitive to η, and so an accurate estimation of η was not required.

Method of Estimating the Risk Free rate

Two forecasts of the risk free rate were made.

1) Implied Risk Free Rate

By taking the natural logarithm of S_t an implied risk free interest rate was generated using Equation 4.0.10 (reproduced below). This was compared to the actual risk free rate.

$$R_f = -\log\delta + \eta g - \eta(1-\theta)(s_t - \bar{s}) - \frac{-\eta^2\sigma_s^2}{2}[\lambda(s_t)+1]^2 \qquad (4.0.10)$$

The series S_t was generated using all the conditional information. Hence, if the specification of the steady habit is corrected, then the series should generate a risk free rate that is close to perfectly correlated with the nominal rate.

2) Static one period ahead forecast

The specification of habit equation 4.0.5 (reproduced below) was used to make a static forecast of S_{t+1}. Using this forecasted series the risk free interest rate equation was used again to generate a static forecast of the risk free rate.

$$s_{t+1} = (1-\phi)\bar{s} + \phi s_t + \lambda(s_t)\mu_{t+1} \qquad (4.0.5)$$

Method of Estimating the Equity Premium

The equity premium was derived using the CCAPM equity premium from IDENTITY 4 reprinted below

$$E[R_{i,t} - R_{ft}] = -E[1+R_{ft}] \times Cov[(1+R_{i,t}), M_t$$

First the series of Arrow-Debreu prices M_t was generated using equation 4.0.9. Then an ARCH (1,1) model was used to estimate the conditional covariance's between risky returns R_{i}, and the Arrow-Debreu prices M_t. An approximation method was used to estimate the ARCH model. Using the fact that a bivariate ARCH (1) can be specified by equations 5.0.3 and 5.0.3, the conditional covariance can be approximated by the static forecasts of the linear equation 5.0.4 estimated using OLS.

$$\mathrm{var}(R_t \mid I_{t\ 1}) = E[(R_t \quad E[R_t])^2 \mid I_{t\ 1}] \qquad (5.0.2)$$

$$\mathrm{cov}[(1+R_t)M_t \mid I_{t\ 1}] = \omega_0 + \omega_1[(1+R_{t\ 1}) \quad E[1+R_{t\ 1}]] \times (M_{t\ 1} \quad E[M_{t\ 1}]) \quad (5.0.3)$$

$$\mathrm{cov}[(1+R_t)M_t \mid I_{t\ 1}] = \omega_0 + \omega_1(1+R_{t\ 1})M_{t\ 1} + \pi_t \qquad (5.0.4)$$

With a conditional covariance series and a forecasted risk free rate, it is straight forward to generate an estimated equity premium using the equity premium CAPM IDENTITY 4. Two equity premium series are generated, one from the in sample period s_t and one from the one period forecasted s_{t+1}.

The forecasts of the equity premium and risk free were compared with the observed series. An OLS equation was run on the forecasted and the actual series to determine whether they are the same. If the forecast is accurate then the joint hypothesis $H_0 : \beta_0 = 0, \beta_1 = 1$ should not be rejected in the following regression.

$$y^{actual} = \beta_0 + \beta_1 y^{forecast}$$

Data

This study required Australian data for non-durable consumption, equity returns, risk free asset returns and price dividend ratios. The sample gathered is at a quarterly frequency over a 28 year period from January 1973 to June 2002. The data were sampled from Datastream International™ The stock market data includes the Australian stock market indicator (with national holidays excluded) quoted in local currency terms. The market index and is calculated by Datastream International™ and are a market capitalisation weighted index incorporating approximately 80% of the market value at any given point in time.

Although a lot of studies in the United States use the Ibbotson Associates data from 1926, there are almost as many using data over shorter time periods, such as fifty, twenty or even ten years to come up with historical risk premiums. The rationale presented by those who use shorter periods is that the risk aversion of the average investor is likely to change over time, and that using a shorter time period provides a more updated estimate. This has to be offset against a cost associated with using shorter time periods, which is the greater noise in the risk premium estimate. Damodaran (2002) finds that, given the annual standard deviation in stock prices between 1926 and 1997 of 20%, the standard error associated with the risk premium estimate is estimated to be 8.94% for 5 years, 6.32% for 10 years, 4.00% for 25 years and 2.83% for a 50 year sample[13].

The data used in the deriving the CRRA, CCAPM and the habit model consists of quarterly observations on Australian data for private household consumption, population, equity returns, risk free asset returns, dividend yields and price dividend ratios. The sample includes 118 quarterly observations over the period 1st Quarter 1973 to 2nd Quarter 2002. At the time of the analysis we used the latest data available all of the data except consumption data was only updated to 2nd quarter 2002. All of the data are obtained from Thomson Financials Datastream package.

The consumption data set is composed from the sets NIFC Private Final Consumption Expenditure Food and the NIFC Private Final Consumption Expenditure Other Non Durables (Excluding Oil). It is normalised to per captia using quarterly population statistics. The population includes every age group, including children, prisoners and invalids who may not be making consumption choice decisions for themselves. Further research may

[13]These estimates of the standard error are probably understated, because they are based upon the assumption that annual returns are uncorrelated over time. There is substantial empirical evidence that returns are

include normalising consumption using a dependency ratio. However, this would be a crude correction. This study assumes that population statistics are an adequate proxy for the number of Australian making consumption decisions.

The risk free rate is represented by the nominal yield on the Australian 90 day Treasury bill. The inflation series is composed from CPI index that excludes oil. Estimations were run with oil but the results are not good. The non-linear nature of inflation is not well accounted for in this model. When oil is removed inflation is more stationary in the mean, and the model performs better.

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correlated over time, which would make this standard error estimate much larger.

Chapter 6:

Results

In this chapter we present the results of the CRRA, CCAPM and habit models. We also look at the actual and implied risk premium given by our model.

Deriving Parameters for the CRRA, CCAPM and Habit models

The AR(1) estimation of the annual price dividend ratio gives a value of ϕ as 0.996 (0.0308). The estimation was annualised to allow for seasonality. However, neither the Augmented Dickey Fuller or Phillips-Perron tests can reject a unit root, hence the estimate and the standard error are irrelevant. Campbell and Cochrane (1995) used a long run price dividend ratio and estimate $\phi = 0.97$ for U.S. stocks. It was this value that was used to estimate S_t.

The consumption growth rate was taken from the mean of the consumption growth series. To estimate a conditional standard deviation σ_{gt} a maximum likelihood GARCH (1,1) is estimated.

Variance Equation for Consumption Growth

$$\sigma_{gt} = -0.0648 \times ARCH(1) + 0.838 \times GARCH(1)$$

$$\quad (0.629) \qquad\qquad (0.212)$$

The mean and standard error of the observed risk premium were 0.02022 and 0.1005 respectively. This gave a lower Hansen-Jagannathan bound of 0.22. Using Campbell and Cochrane's table (Table 1) η was estimated to be 2.5. Remember that η is not sensitive to the Hansen-Jagannathan bound, so an approximte estimation should not cause problems with the model. The last parameter to be estimated was the discount rate, δ. Most studies find that a reasonable value discount value is between 0.95 and 0.98. Campbell and Cochrane (1995) used 0.98, while Engsted (1998) chose the lower bound of 0.95. This study takes an intermediary value of 0.97, which was similar value to the reciprocal of one minus the mean of the risk free rate.

Table 2 – Parameter and Brief Statistics

Parameter	Quarterly	Annualised
ϕ	0.98	0.92
Mean return of equity	3.13%	12.53%
Mean risk free rate	0.89%	3.56%
Mean risk premium ($R_i - R_f$)	2.022%	8.09%
Std error risk premium	9.75%	39.0%
$\overline{g_t}$	0.467%	1.89%
$\overline{\sigma}_{g_t}$	0.978%	7.57%
η	2.5	
δ	0.97	
Hansen Jagannathan Ratio	0.207	0.207
Covariance g and R	10.10	40.41

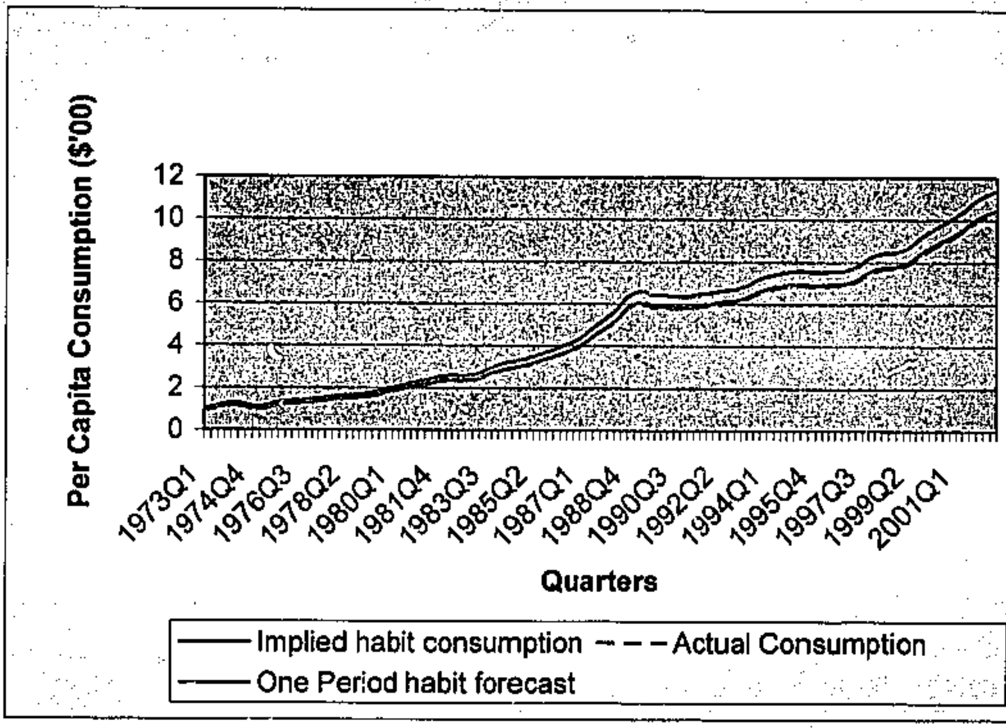
Generating Implied Habit Consumption

Implied habit was derived using equation 4.0.2 reprinted below.

$$S_t = \frac{C_t - X_t}{C_t}$$

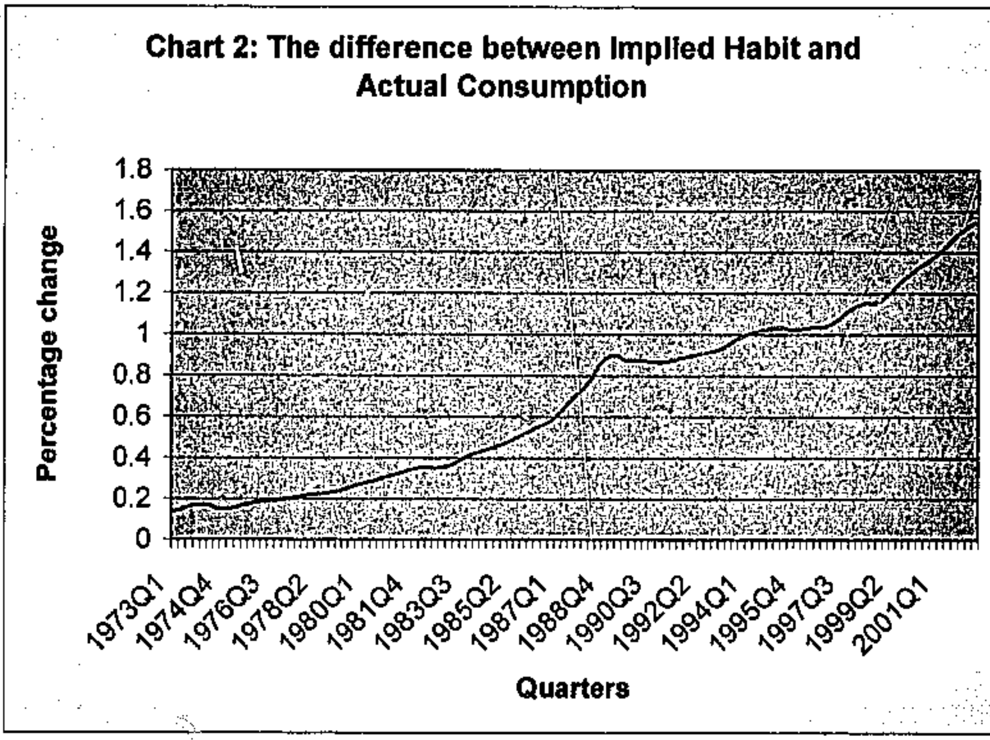
Using the one period ahead forecast of S_{t+1}, a series of implied habit forecasts was made. Chart 1 shows implied habit and static forecast habit along with observed consumption. The series are very similar, which is not a surprise as ϕ is so close to one. Notice that, as expected, the volatility of implied habit (s.e. = 0.298) is slightly greater than the volatility of the forecast habit series (s.e. = 0.297).

Chart 1: Implied Habit Consumption and Actual Real Consumption per Capita



The above curve for the three consumption series are very close thus indicating the smooth consumption patterns observed when we compare actual consumption and the implied or derived consumption series. This clearly addresses the issue of smooth consumption patterns that Mehra Prescott reffered to in the seminial papers on the equity premium puzzle.

An interesting phenomenon is that implied habit and actual consumption are diverging. Chart 2 plots the divergence. This means that utility is increasing slowly through time. It also means that either consumption is growing unexpectedly fast or habit it reaching as asymptotic limit. A limit would imply that one day consumption would rise to such as level that an ultimate habit level is reached. If consumption kept growing after habit levelled out then utility would rapidly increase. An alternative explanation for the divergence between habit and consumption is that the long run consumption growth rate or the price dividend autocorrelation coefficients were inaccurate.



The Risk Free Rate

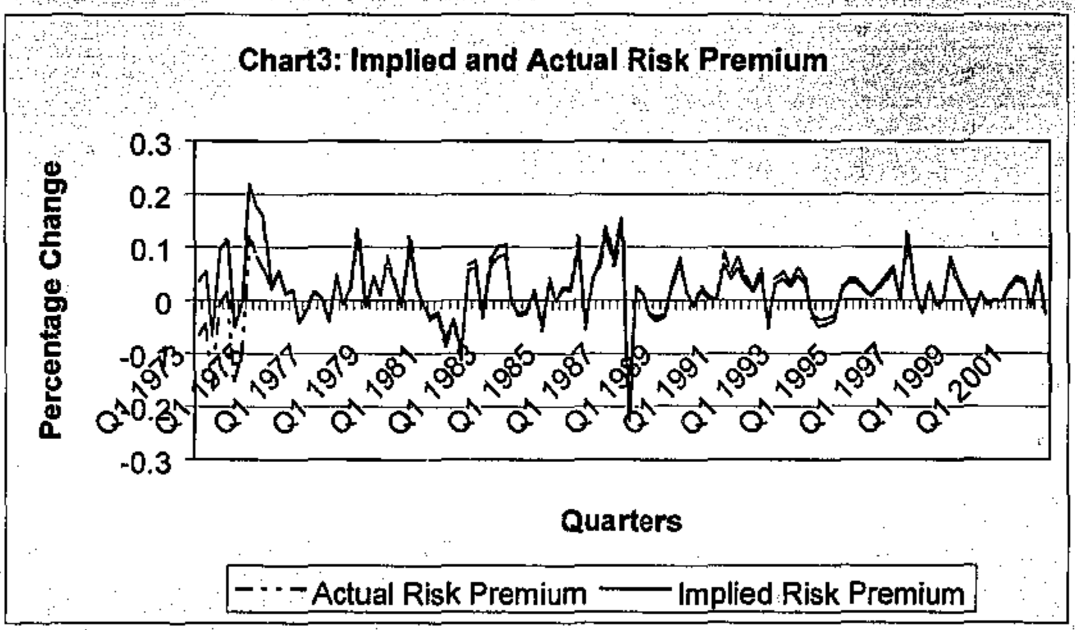
Having made the assumption of a constant risk free rate, the forecast and actual risk free series were not expected to be very closely related. Table 4 presents the OLS regression for collinearity. Wald tests rejected the hypothesis that either forecast series is the same as the actual rate. The f-stat for the implied risk free rate rejects the OLS equation altogether. This does not matter because it is only an implied rate, and the regression could not reject a positive relationship with $\beta_1=1$. Of more concern is the static forecast regression. It is significant with a negative β_1 coefficient, implying a negative relationship. Clearly this is an inadequate forecast. Still it is the equity premium, not the risk free rate, that the model is interested to forecast. The risk free rate is generated because it is needed for the premium's estimation.

The Equity Premium

Table 4 shows that Campbell and Cochrane's risk premium equation has some predictive power. The F-statistic indicates that the equation for the risk premium has some limited explanatory power. Note that although Wald tests reject the hypothesis that the series are the same, they do not reject the hypothesis that the series are perfectly correlated ($\beta_1=1$), although this is not clear looking at Chart 3 and 4. It was concluded that this was due to the series having significantly different means. As previously mentioned, the expected risk premium is 2.2%. The mean risk premiums using recursive utility were –0.89% and –0.90% (Table 3) respectively, which implies the market portfolio is a consumption hedge. However, the standard errors for these means are large, 1.20% and 1.19% respectively. Consequently, there is little accuracy in the estimations of the mean risk premium. Even still, the 95% confidence interval does not extend to include the actual risk premium of 2.2%. Also, the standard errors are substantially less than the standard error of the observed risk premium, 10.1%. It appears that the model still cannot account for the large variability in equity returns compared with consumption variability. This was probably due in part to the composition of the market portfolio. It is made entirely of equity, from which only a small proportion of the population derive consumption. It may be that the model is predicting the volatility of the true market portfolio – a portfolio that includes broader capital such as property and human capital. Nonetheless, the equity portfolio was used because this was the type that was used my Mehra and Prescott (1985) and subsequent papers. One part of this study was to show that an alternative utility function can resolve their puzzle. If the type of portfolio was changed then there would be no control study.

Table 3 – Risk Premium Results

	Actual Risk Premium	Implied Risk Premium	Forecast Risk Premium
Mean	2.2%	-0.89%	-0.90%
Standard Error	9.75%	1.20%	1.19%



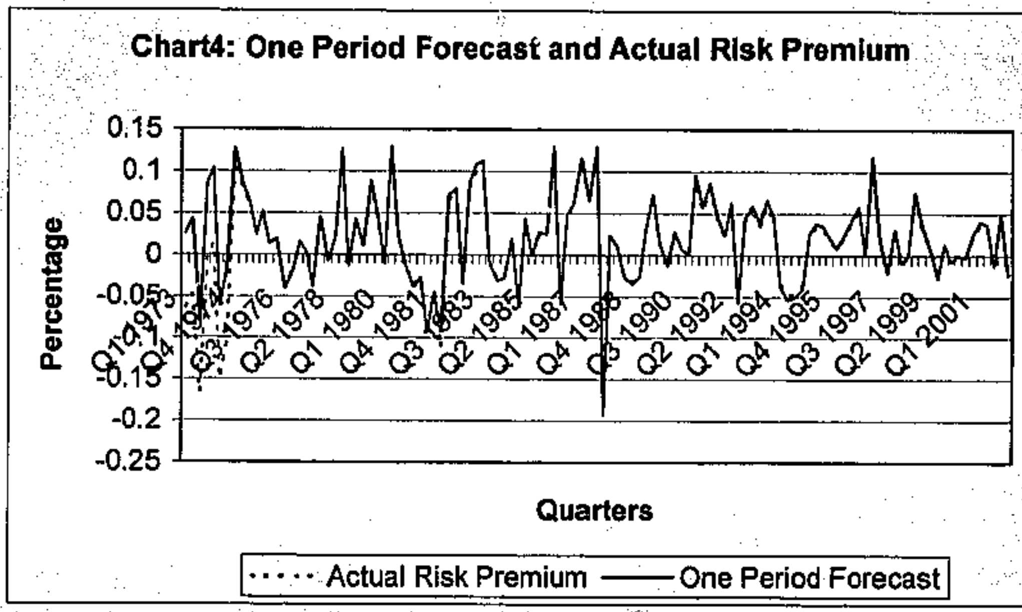


Chart4: One Period Forecast and Actual Risk Premium
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
Percentage
Quarters
Actual Risk Premium
One Period Forecast

Table 4 – OLS Regression for collinearity

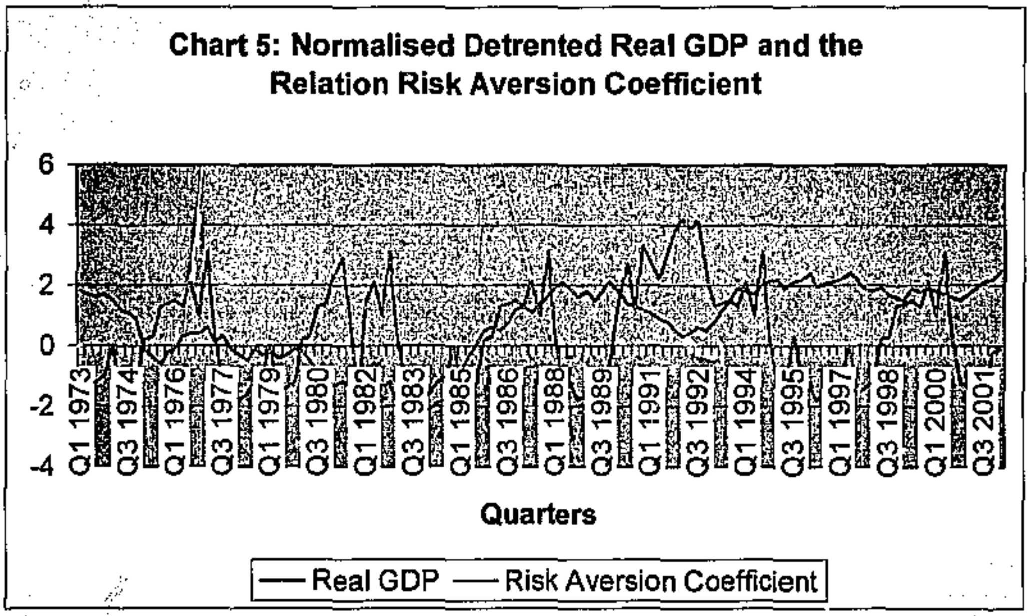
	Implied Risk Free Rate	Static Forecast of Risk Free	Implied Risk Premium	Static Forecast of Risk Premium
β_0	0.018642 (0.0150)	0.036960 (0.110)	0.0337 (0.00961)	0.0330 (0.00965)
β_1	-0.614316 (0.9412)	-1.824808 (0.689)	1.210 (0.518)	1.240 (0.541)
R^2	0.002851	0.034764	0.036006	0.034764
F-Stat (P-value)	0.426038 (0.5149)	7.014960 (0.00896)	5.416 (0.021338)	5.258 (0.023269)
P-Value H_o: $\beta_0 = 0$ & H_1: $\beta_1 = 1$	0.000000	0.000000	0.000999	0.00134
P-Value H_0 : β_1 : = 1	0.086304	0.000041	0.690860	0.658159

The Coefficient of Relative Risk Aversion

Equation 4.0.8 is reproduced below and from it a series of the risk aversion coefficient was generated

$$\gamma_t = {}^{\eta}\!/_{S_t}$$

The average surplus consumption ratio, $\bar{S}$, is 0.154. This implies an average risk aversion coefficient of 16.23, which is less than the CRRA result of 19.4 from section 3.4. Significance tests reject that the habit risk aversion is insignificantly different from CRRA relative risk aversion. One of the benefits of the habit model is that it allows for time varying risk aversion coefficients and a series is generated. Chart 5 shows the time varying γ_t along with detrended consumption and real GDP. Note that risk aversion increases as output and consumption decline. The derivation of this model requires that the consumption and the risk aversion coefficient are contemporaneously correlated but the relationship with output may be different. Sengupta (1992) suggests that risk aversion changes before output falls. Business confidence is frequently reported in the media as a weak predictor of business cycles. Further work could test whether the assumption of contemporaneous risk aversion is adequate.



The time varying risk aversion coefficient is negatively, but weakly correlated with detrended real GDP, as shown in Chart 5. Note the large increases in risk aversion in 1974, 1975, 1978 and in 1989, corresponding to recessions, OPEC shocks and the senate blocking of supply in 1975. The recession of 1983 does not have a very large risk aversion coefficient. The only way the model could allow for such an anomaly is if people in the early eighties had foreseen the recession and revised habit before consumption fell. Risk aversion is highest when there are unforeseen consumption shocks. In this sense risk aversion may be able to predict recessions assuming consumption shocks precede output shocks. For curiosity the results for Granger Causality test are tabulated in Table 5. Causality is rejected for all lags. Nonetheless, further work may find some causality because it looks like it does exist in Chart 4.

Table 5: Granger Causality test for risk aversion predicting output shocks

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 8	Lag 10	Lag 12
γ_t does not Granger cause rGDP	0.54154	0.27442	0.47044	0.65615	0.94182	0.83427	0.64042

Consumption Volatility

Table 6 summarises the market volatility results. The standard error for the Arrow-Debreu asset prices is 0.152. From section 3.4, the Hansen – Jagannathan lower bound was 0.22. However, this is still an improvement on the CRRA Arrow-Debreu volatility of 0.12. A variance ratio test rejected the hypothesis that the variance of the habit Arrow-Debreu assets were the same as the CRRA volatility or the Hansen – Jagannathan lower bound. The habit model is able to account for more of the variability in equity than the CRRA model. The smooth consumption puzzle is not as severe with the habit model.

Table 6: Volatility of Australian Market Portfolio

Hansen Jagannathan Lower Volatility Bound	0.22	
	CRRA	Habit Model
Estimated Volatility	0.12	0.152

Chapter 7

Conclusions

In Chapter 2 we looked at the in-sample and out-of sample forcastability of the equity premium using lagged dividend yields. We found some promising results prior to Oct 1987 but due to the weak power of the dividend yield since 1987 we attempted to approach the issue of equity premiums based on more sophisticated models.

The second part of the dissertation established that the habit utility specification of Cambell and Cochrane (1995) is theoretically superior to a CRRA specification and that it empirically performs marginally better than CRRA utility on the basis of predicting stock volatility and returns. The research has also shown that habit utility is able to reproduce an equity premium that is comparable to the actual equity premium.

The implication is that preferences are not completely rational. This has ramifications for Ricardian equivalence and Hall's random walk. If habit is persistent, than fiscal shocks will have persistent effects under certain circumstances. Provided consumers can not substitute the increased government consumption for private consumption, total consumption will increase. Once the new consumption level is reached, habit will cause the shock to persist, so that when there is a fiscal contraction, aggregate demand will be maintained. Ricardian equivalence is yet to be empirically proven (Gulley 1994, Vamvoukas 1998), but the results of this study suggest the hypothesis is weak.

Further research should incorporate general equilibrium analysis to improve the model. Epstein and Zin (1989) realise their model is not integrated into a general equilibrium, and the same can be said for this model. The approach taken by Campbell and Cochrane is to assume a Robinson Crusoe economy. There is no production and so all expectations are based on partial equilibrium forecasts. Further research could follow Abel (1990) and incorporate the habit specification of Campbell and Cochrane into a Lucas (1978) asset pricing model.

If habit is a robust phenomenon, then it has growth policy implications. This study has shows that utility grows a lot slower than the growth rate of consumption. If utility is obtained from surplus consumption then policy should move from emphasising consumption growth to smoothing consumption shocks. Although this study supports the existence of habit, the results are not clear enough to justify such a policy shift. Further development and testing of habit utility is still required.

Finally Campbell and Cochrane's model is able to alleviate part of the equity premium puzzle in Australia. The relative risk aversion coefficient and the estimated volatility of returns are both more acceptable. The habit model still does not completely resolve either of these problems – stock volatility is still too high compared to consumption volatility, and the coefficient of risk aversion is unreasonable – however, the habit specification has alleviated the discrepancy.

The ulitmate way to truly measure the average premium in Australia would be to do a survey of analyst's and brokers to see their level of risk aversions before looking at the individual investor levels. This study has already been done in the United States by Ivo Welch (2001) and results of these study have been published in NBER. This paper presents the results of a survey of 510 finance and economics professors. The consensus forecast for the 1-year equity premium is about 3% to 3.5%, the consensus forecast for the 30-year equity premium (arithmetic) is about 5% to 5.5%. The consensus 30-year stock market forecast is about 10%. These forecasts are considerably lower than those taken just 3 years ago. The risk premium from the survey are much less than the ones reported by Ibbotson and Associates stating the most academics believe that the relative risk aversion is might higher and that perhaps the equity markets have grown too big.

As an overall summary we must note the importance of further studies on the equity premium. As the key to estimating long-rum stock return, the equity risk premium plays an important role in a host of financial decisions. The most obvious use of an estimate of the premium is for making assset allocation decisions. A basic decision that every investor must make is how to divide his or her portfolio amoung stock, fixed-income securities, and other assets. This is commonly referred to as the asset allocation problem. The fundamental data on which this decision is based are estimates of the relative risks and expected returns for the competing asset classes. In the case of stock and fixed-income securities, the relative return is precisely the equity risk premium.

Aside from playing a central role in asset allocation, the equity risk premium is also a critical input into planning decisions for pension funds and retirees. Planning for retirement necesssiates approximating the funds that will be available in the future. This requires estimates of the returns on investments. For fixed-income securities, the calculation is straightforward because the yields are known. For equities, however, it requires an estimate of the market risk premium. In the case of fixed-benefit plans, the burden of estimating the equity risk premium switches from the retiree to the company. Funding requirements for fixed-benefit plans depend on the assumptions made regarding investments returns. Those assumptions, in turn, depend on the equity risk premium.

Appendix A

In Chapter 2 we calculate the equity indicies and dividend yield as follows:

For equity indices, the calculation used is:

$$MV_t = \sum_{1}^{n} (P_t * N_t)$$

Where N_t = number of shares in issue on day t

P_t = unadjusted share price on day t

For sectors, dividend yield is derived by calculating the total dividend amount for a sector and expressing it as a percentage of the total market value for the constituents of that sector. This provides an average of the individual yields of the constituents weighted by market value. It is calculated as follows:

$$DY_t = \frac{\sum_1^n (D_t * N_t)}{\sum_1^n (P_t * N_t)} * 100$$

where DY_t = aggregate dividend yield on day t

D_t = dividend per share on day t

N_t = number of shares in issue on day t

P_t = unadjusted share price on day t

n = number of constituents in index

A return index is available for a range of sectors and market indices, including Datastream Global Indices. The return index represents the theoretical aggregate growth in value of the constituents of the index. The index constituents are deemed to return an aggregate daily dividend which is included as an incremental amount to the daily change in price index. The Return index (RI) for the total market series is calculated in the following as follows:

$$RI = RI_{t-1} * \frac{PI_t}{PI_{t-1}} * (1 + \frac{DY}{100 * n})$$

where RI_t = return index on day t

RI_{t-1} = return index on previous day

PI_t = price index on day t

PI_{t-1} = price index on previous day

DY = dividend yield of the price index

n = number of days in financial year (normally 260)

P_t = unadjusted share price on day t

Appendix B

Mean absolute Error (MAE): This is the average of the absolute values of the forecast errors. It is appropriate when the cost of forecast errors is proportional to the absolute size of the forecast error. This criterion is also called MAD (mean absolute deviation).

Root mean square error (RMSE) This is the square root of the average of the squared values of the forecast errors. This measure implicitly weights large forecasts errors more heavily than small and is appropriate to situations in which the cost of an error increases as the square of that error. This "quadratic loss function" is the most popular in use.

Mean absolute percentage error (MAPE) This is the average of the absolute values of the percentages errors; it has the advantage of being dimensionless. It is more appropriate when the cost of the forecast error is more closely related to the percentage error than to the numerical size of the error.

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