IS THERE A RELATIONSHIP BETWEEN THE RISK-FREE RATE AND THE MARKET RISK PREMIUM IN AUSTRALIA? EMPIRICAL EVIDENCE

Duc Vo*

Stefan Mero

Beauden Gellard

Rajat Sarawat

Economic Regulation Authority

469 Wellington Street, Perth, WA 6000, Australia

Phone: (08) 6557 7900

Fax: (08) 6488 1016

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Abstract

Australian economic regulators such as the Economic Regulation Authority and the Australian Energy Regulator have generally accepted the existence of the "flight to quality" phenomenon during times of crisis in equities markets. However, studies are yet to examine this phenomenon within an Australian context. Over the last two years, estimated required returns on equity derived by Australian regulators have been relatively low due to a significant fall in the estimated risk free rate of return in comparison with its previous levels. Australian regulated businesses have argued that the risk-free rate of return is historically low due to a flight to quality in the Australian financial market. They have also argued that there is a negative relationship between the market risk premium (MRP) and the risk-free rate. It follows, according to the argument put forward by the regulated businesses, that any reduction in the risk-free rate will be offset by a corresponding increase in the MRP, thus leaving the return on equity unchanged. Using an event study methodology together with other techniques, this paper tests for the existence of evidence of a "flight to quality" triggered by equity market crashes in Australia. This paper failed to identify evidence to support the existence of a flight to quality. That is, there was no evidence of a transfer of investment funds from the Australian equity market to the Commonwealth Government bond market during 14 equity market crashes that have occurred during the last 30 years (1983 to 2012). In addition, our empirical study finds that it is possible that a reduction in the risk-free rate of return in Australia is not associated with any change in the Australian market risk premium.

JEL Classification Numbers: *G01; G11; G18*

Keywords: *Flight to quality; market risk premium; risk-free rate of return; regulation; Australia.*

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I Introduction

Australian economic regulators such as the Economic Regulation Authority and the Australian Energy Regulator have adopted the Sharpe-Lintner capital asset pricing model (the CAPM) to determine the required rate of return in their regulatory decisions. Over the last two years, an estimated required return on equity in regulatory decisions has been substantially lower due to a significant fall in the risk free rate of return in comparison with its previous levels. Australian regulated utilities and their consultants have raised their concerns in relation to the adoption of the Sharpe-Lintner CAPM in estimating a return on equity by regulators and the approaches in which the inputs of the model, namely the market risk premium (MRP) and a risk-free rate of return, are estimated.

The key arguments raised by regulated utilities is that: (i) a risk-free rate of return is at historical low due to a flight to quality in the Australian financial market; and that (ii) there is a negative relationship between the MRP and a risk-free rate, as such, from their argument, any reduction in a risk-free rate will be offset by a relative increase in the MRP, leaving the return on equity unchanged.

The purpose of this paper is to respond to the above two concerns raised by regulated businesses. Following this Introduction, Section II presents a theoretical concept regarding a relationship between a MRP and a risk-free rate within the CAPM framework. An empirical study to test the hypothesis of a flight to quality in the Australian financial market, which is in response to the first argument, is presented in Section III. Section IV presents an empirical evidence of a co-integration between the market risk premium and a risk-free rate which is in response to the second argument. Concluding remarks are presented in Section V.

II Theoretical considerations

The key concern raised by regulated businesses is that the MRP and risk free rate of return are negatively correlated. As such, any reduction in the risk free rate of return is offset by an increase in the MRP, leaving a return on equity unchanged. We will respond to this argument by revisiting the framework of the Sharpe-Lintner CAPM, which is adopted to estimate the return on equity for regulated businesses, and providing some interpretations of how this model can be consistently used in the context of a low risk free rate.

(i) A modern portfolio theory

Modern portfolio theory (MPT) seeks to determine how a rational investor will allocate capital between various securities. By combining stocks in a portfolio, the MPT demonstrates that investors can achieve superior levels of expected return by taking on a given level of risk than that which could be achieved by holding individual stocks. In addition, this MPR theory also assumes that investors can borrow and lend their capital at the risk free rate. In this context, the MPT theory presents that an optimal portfolio exists, to be called the market portfolio, which maximises the expected return per unit of risk. Investors then determine the proportion of capital they allocate between a risk-free asset, which is risk-free, and the optimal market portfolio, which is risky, through their preference for risk.

Formally, an investor is presented with a universe of stocks that are assumed to be random variables. Each stock is therefore assumed to have a probability distribution, with the mean of the distribution determining the expected return of the stock and the variance of the probability distribution determining the level of risk. In addition, each stock is assumed to be related to all others via the correlation between itself and the other stocks in the portfolio. In this situation, the expected return and variance of a portfolio of *n* stocks can be summarised as below:

$$E[R] = \sum_{i=1}^{n} w_i \mathrm{x} E[r_i] \quad (1)$$

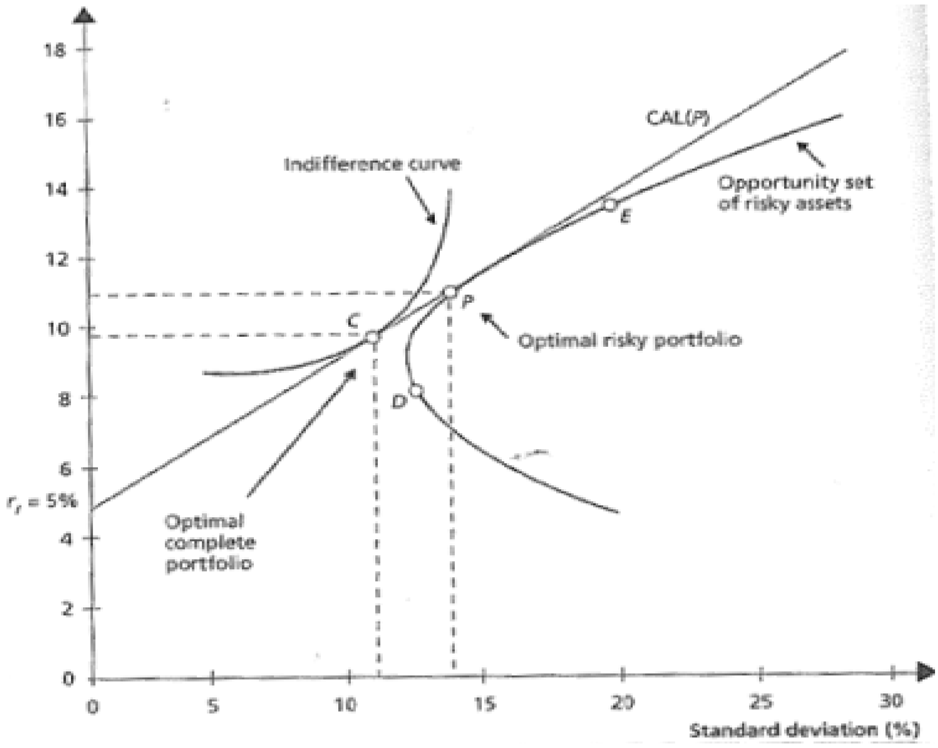
$$\sigma_p^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j \neq i}^{n} w_i w_j \sigma_i \sigma_j \rho_{ij} \quad (2)$$

Investors seek to maximise the expected return per unit of risk, or $\frac{E[R]}{\sigma_p}$. For a given level of a risk, the maximum expected return is calculated by choosing the portfolio weights which maximise the expected return per unit of risk ratio, which is $\frac{E[R]}{\sigma_p}$. By varying the level of risk and performing this optimisation, an "efficient frontier" of portfolios can be constructed which achieve the optimum expected return for a given level of risk.

This model is then extended further by allowing for the existence of a risk-free asset. In this context, capital can be allocated to the risk-free asset such as the Commonwealth government securities, together with a portfolio of stocks. Alternatively, capital can be borrowed at the risk-free rate of return and then it is invested in a portfolio of stocks. In this case, it can be shown that an *optimal* portfolio of stocks exist that has a superior expected return per unit of risk. By allocating capital between the risk-free asset and this *optimal portfolio*, the superior expected return per unit of risk ratio can be preserved. The investors desired level of risk can be achieved via this mechanism. As a consequence, all rational investors who seek to maximise the expected return per unit of risk will choose to hold a proportion of their capital in this optimal portfolio, and the remaining proportion in the risk free asset. By choosing the proportions of capital allocated between the optimal portfolio and risk-free asset, the desired level of risk can be achieved that maximises expected return.

Figure 1

Capital Market Line



Source: Bodie, Kane & Marcus (1999)

As presented in Figure 1, the allocation of capital between the optimal risky portfolio and the risk-free asset is shown above in the capital market line (CML). Point P represents the optimal portfolio that maximises the expected return per unit of risk. Given that the CML dominates the efficient frontier of risky assets, investors are able to achieve superior risk return combinations by investing in both the risk-free asset and the optimal portfolio. The choice of portfolio is determined by the investor's indifference curve, which represents the risk-return combinations that give the investor the same level of utility. A rational investor will attain the highest indifference curve possible, representing the highest level of utility possible from investing. Therefore, an investor will allocate their capital at point C above, where the highest possible indifference curve is tangent to the capital market line.

The *optimal* portfolio is known as the *market* portfolio as this portfolio must contain all risky assets. Given that diversification reduces the unsystematic risk of the portfolio, only systematic risk remains in a diversified portfolio. It is assumed that diversification is costless, and as a consequence, return is only achieved by bearing systematic risk. The optimal portfolio will therefore only compensate investors for bearing systematic risk, as unsystematic risk is costless to diversify away. As systematic risk is market risk, the fully diversified portfolio will contain only macroeconomic risks, and as a consequence investors will only earn a return for bearing macroeconomic risks.

From the above analysis, the return of an individual security is related to the covariance the security has with the returns of the market portfolio. As investors earn no return for bearing unsystematic risk, it follows that the return of an individual security will be related to the degree of systematic risk inherent in the security. The covariance between the market portfolio and the individual security represents the degree of systematic risk presented in the individual security. The sensitivity between a security and the market is referred to as a beta, β and this beta represents the degree of systematic risk presented in a security.

The expected return of the risk-free asset corresponds to an asset having a beta of zero because a risk-free asset faces no systematic risk. The return of the market portfolio as a whole corresponds to a beta of 1, as by definition the market portfolio is the benchmark for systematic risk. Assuming that the return of an individual asset is linearly related to its β, these 2 points can be used to construct the Security Market Line (SML) as follows:

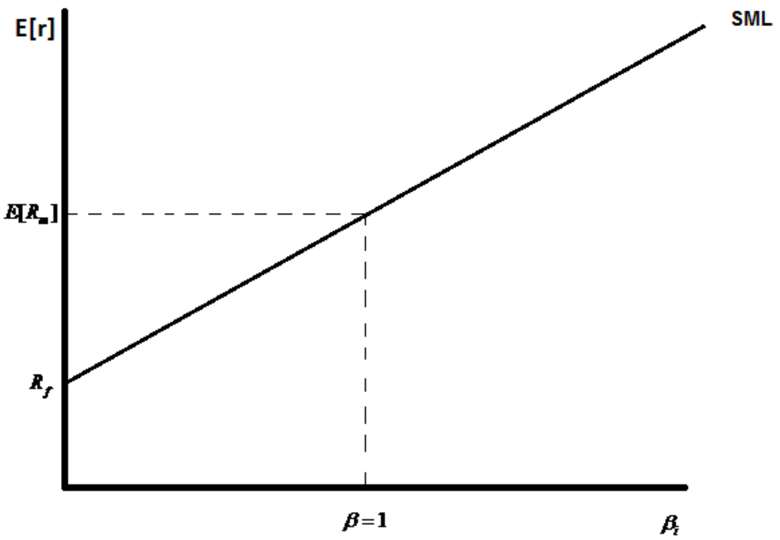
$$SML: E[R_i] = R_f + \beta_i (E[R_m] - R_f) \quad (3)$$

where:

- $E[R_i]$ *is the expected return of security i.*
- R_f *is the risk free rate of return.*
- β_i *is a measure of the systematic risk present in security i.*
- $E[R_m]$ *is the expected market return.*

The difference between the expected return for security *i* and a risk-free rate of return, $E[R_m] - R_f$, is generally referred to as the market risk premium (MRP). The MRP represents the premium investors earn over and above the risk-free rate of return for bearing systematic risk. This situation can be represented graphically showing the relationship between a securities expected return $E[R_i]$ and a security β. As a result, the intercept represents the risk-free rate of return, whilst the slope of the SML is the market risk premium. The SML representation is also known as the Sharpe-Lintner CAPM.

Figure 2
Security Market Line



It can be shown that a security β is determined by the following equation:

$$\beta_i = \frac{Cov(i, Mkt)}{\sigma_m^2} \quad (4)$$

where: $Cov(i, Mkt)$ *is the covariance of security i with the market portfolio,* σ_m^2 *is the variance of the market portfolio.*

(ii) Changes in the SML in responses to a reduction in a risk-free rate of return

There are three different possibilities of a shift in the SML, or the Sharpe-Lintner CAPM, in response to a reduction in the risk-free rate of return, which are:

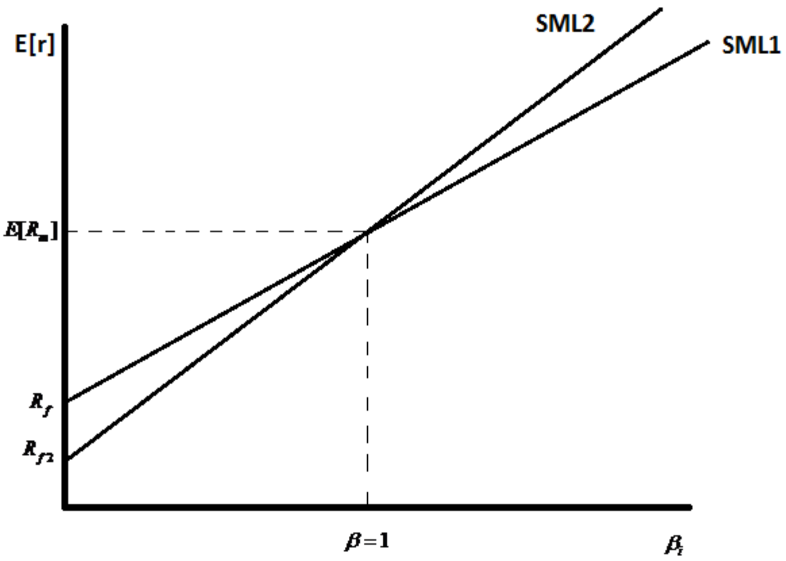
- a reduction of a risk-free rate is associated with an increase in the MRP, *Scenario 1*
- a reduction of a risk-free rate is not associated with any change in the MRP, *Scenario 2*
- a reduction of a risk-free rate is associated with a decrease in the MRP, *Scenario 3*

Scenario 1: A reduction in a risk-free rate of return results in an increase in the MRP

An inverse relationship between a risk-free rate of return and a MRP will occur when there is a pivot of a SML around the market portfolio which the beta is 1. Figure 3 presents that, when a risk-free rate of return decreases from R_f to R_{f2}, then the slope of the SML increases which is represented for an increase in the MRP. As a result on a theoretical ground, there may be a merit for a view of an inverse relationship between a risk-free rate and a MRP.

Figure 3

An inverse relationship between a risk-free rate and a MRP



Scenario 2: A reduction in a risk-free rate of return leaves the MRP unchanged

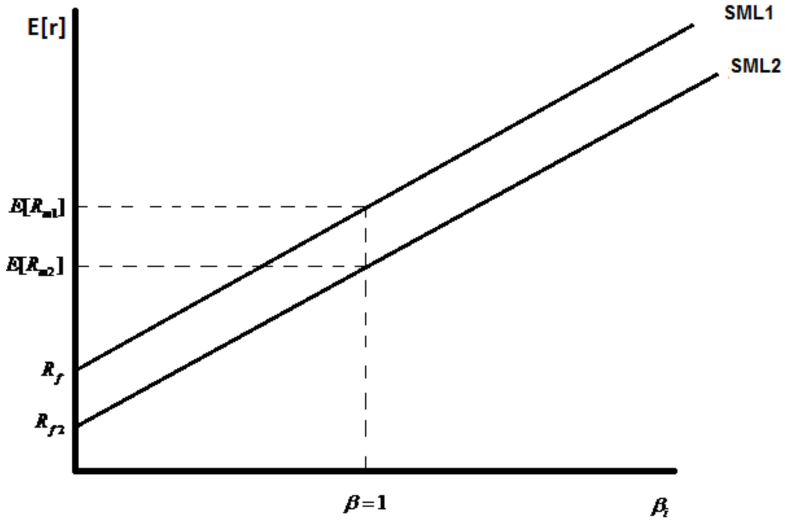
1. The second scenario, as presented in

Figure ***4*** below, illustrates for a paralleled shift downwards of the SML, from the SML_1 to SML_2, in response to a reduction of a risk-free rate of return from R_f to R_{f2}. In this scenario, a slope of the SML remains unchanged, which represents for an unchanged MRP, after a reduction in a risk-free rate.

The Authors are of the view that *Scenario 2* is appropriate for a relationship between a risk-free rate of return and a MRP on a theoretical consideration.

Figure 4

A reduction of a risk-free rate is associated with an unchanged MPR



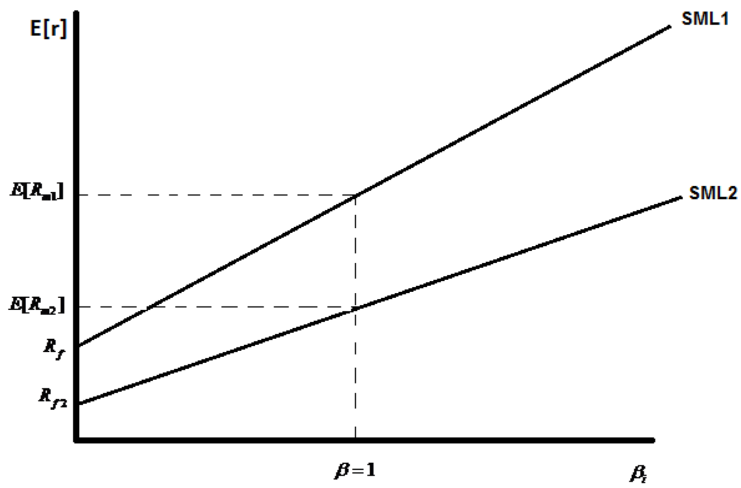
Scenario 3: A reduction in a risk-free rate of return results in a reduction in the MRP

It is also possible that the SML shifts downwards in response to a reduction of a risk-free rate of return. However, this shift does not take place in parallel. It means that the slope of a new SML, SML_2, is flatter in comparison with the slope of the original SML, SML_1. In this case, a reduction of a risk-free rate results in a lower expected return in the market generally and a reduction of a MRP.

The Authors are of the view that, it is also appropriate to consider *Scenario 3* on theoretical grounds.

Figure 5

A positive relationship between a risk-free rate and a MRP



In conclusion, we consider that it is appropriate to consider one of the above three scenarios as an equal possibility of a relationship between the risk-free rate of return and a MRP in the Australian financial market. Since theoretical considerations cannot provide firm evidence in relation to a possibility happening in the Australian financial market, the Authors consider that empirical evidence, will help form a view on the relationship between the two parameters.

III A flight to quality in the Australian financial market?

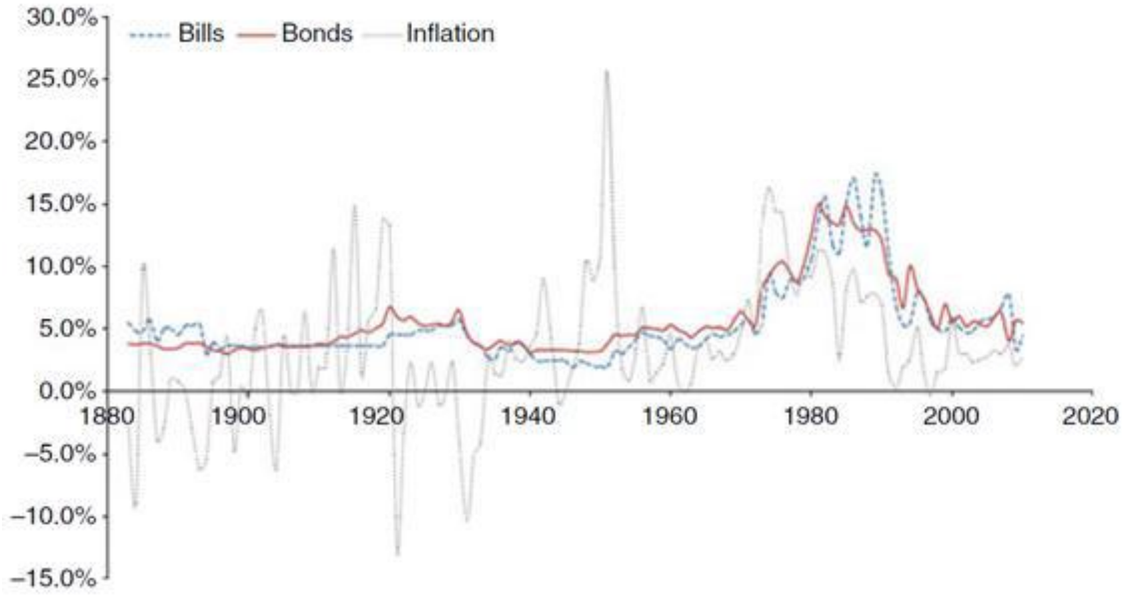
(i) Is Australian risk-free rate historically low?

Australian regulated businesses considered that the Australian risk-free rate of return is historically low. We agree with McKenzie and Partington (2013) that classifying current interest rates as being abnormally low is a relative statement. *McKenzie* and Partington considered that a commonly used method is to assess the current interest rate against a long history of data. They then considered the history of yields in the USA, UK and Australia with the view that the lessons provided by the USA and UK are relevant for Australia as they have a greater length of historical data of interest rates. McKenzie and Partington concluded that it is the period of high interest rates in the seventies, eighties and nineties that are the best candidate for being abnormal, rather than the current "low" rates.

In addition, after reviewing various studies on the long historical interest rates, in both nominal and real terms, in the US, the UK, and Australia, McKenzie and Partington were of the view that the more recent history of interest rates is not truly representative of the long run in this market. They also argued that evidence exists which suggests that bond yields were stable (and possibly even falling) in the long run for the US, UK and Australian markets. They considered that the more recent history is anomalous and the high interest rates observed during this period are clearly not representative of the longer time series. As such, one conclusion that may be drawn is that the current level of interest rate is a return to the 'normal' long run interest rate regime. On the other hand, they also argued that there is a new normal and the most recent global financial crisis represents a true regime shift for global financial markets. However, they acknowledged that it is difficult to determine whether this is the case or not, and that only in the fullness of time will we be able to comment on this with any certainty.

Figure 6

Bond yields, Bill yields and Inflation rates, 1880 - 2012



Source: Brailsford et al (2012)

As such, it is unclear that the current level of a risk free rate in the market is at its historical low. The argument raised by regulated businesses has not been substantiated based on robust evidence. Another related issue raised by regulated businesses is that there has been a flight to quality in the Australian financial market which is considered next.

(ii) Literature review

Academic studies have shown considerable empirical evidence in support of a 'flight-to-quality', shown by a negative correlation between the equities markets and bond markets during times of uncertainty within equities markets around the world.

Chordia, Sarkar and Subrahmanyam (2001) examined the impact of financial crises, monetary policy and mutual fund flows on financial market liquidity over 17 June 1991 to 31 December 1998. The authors observed that financial crises, such as the Asian Financial Crisis (from 1 October to 31 December 1997) and the Russian Default Crisis (from 6 July to 31 December 1998) are accompanied by a decrease in fund flows to equity funds and an increase in flows to the American Government bond funds, resulting in higher bond market liquidity. The authors concluded that this evidence supports a "flight-to-quality" during times of financial uncertainty.

Gulko (2002) tested the hypothesis that the stock-bond correlation is positive before equity market crashes and negative in the aftermath. The author examined daily returns of the Standard and Poor's (S&P) 500 Index and the on-the-run United States (US) Treasuries, the most frequently traded bonds, over 1946 – 2000. A short run event study around equity market crashes was constructed. The author defined equity market crashes as where the S&P 500 index decreased by more than five per cent in a single trading day. The author reported a statistically significant positive correlation between equities and bonds for the ten trading day period before crashes, which reversed in the period spanning two days before crashes until ten days after. The author interpreted this as evidence supporting a 'decoupling' between the two markets as investors flee to the relative safety offered by American Government Bonds.

Li (2002) examined the correlation between daily observed returns on equity and long-term government bonds over the period from 1958 to 2001 for the G-7 nations, including France, Germany, Italy, Japan, The United Kingdom, US and Canada. Equity indices are value-weighed broad market indices whereas the long-term bond indices are used to represent the benchmark government bond indices. A perfect correlation of one (either positive or negative) means that if the market for equity (bond) moves a given amount in a given direction, the market for bond (equity) will also move in perfect synchronisation. The author observed that the degree of correlation between the two markets was ranged from 0.2 to 0.3, meaning that movements in the stock market were mirrored in the bond markets to a degree of 20 per cent to 30 per cent.

Illmanen (2003) examined the yearly correlation between the US stock market, approximated by the S&P 500 Index, and the bond market, approximated by the 20-year Treasury bonds over December 1926 to December 2001. The author reported that while the correlation between the two tends to be positive, there are periods of negative correlations, 1929 – 1932, 1956 – 1965 and 1998 – 2001. The author interpreted this as evidence of a 'decoupling' between the two markets in times of uncertainty.

Dopfel (2003) examined the monthly stock and bond index correlation in the United States over January 1976 to December 2002. Equity returns were based on the S&P500 Index and bonds from the Lehman Brothers Aggregate Bond Index. The author observed that while the correlation was positive on average, there were four years when a negative correlation between the two markets was observed, including 1987, 1998, 2001 and 2002. The author interpreted this as evidence in support of a decoupling of the two markets in times of crisis as investors seek a flight-to-quality from equities markets into bond markets.

Connolly, Stivers and Sun (2005) examined whether equity market uncertainty, approximated by volatility, affects equity and bond market correlation. The authors examined daily equity data over 1988 to 2000 using the Chicago Board Options Exchange (CBOE) Volatility Index, calculated from the implied volatility of S&P100 index options. Bond data was taken from 10 year and 30 year US Treasury bond yields. The authors observed that in periods where volatility is low, equities and bonds display a positive and reliable correlation. However, the correlation reverses when volatility is high. The authors also observed that bond returns and changes in volatility are positively related, suggesting that investors rebalance their portfolio towards bonds in times of high equity market uncertainty.

Baur and Lucey (2009) examined the existence of a "flight-to-quality" phenomenon within European and American markets over 30 November 1995 to 30 November 2005. The authors used daily returns from MSCI stock and bond indexes MSCI Bond indexes represent total sovereign returns for bonds with maturities greater than ten years. The authors observe a negative correlation for transitory periods around market crises including the October 1997 equities market crashes, the Russian crisis in June 1998, the introduction of the Euro in January 1999 and 2002, the 2011 September 11 terrorist attacks and the beginning of the war in Iraq in March 2003. The authors observe changes in the magnitude of the correlation of as much as 0.6 within a period as short as 20 trading days and interpreted this as evidence that equity and bond markets can decouple quickly.

Kim, Moshirian and Wu (2006) observed a consistent role of stock market uncertainty in many European markets. The authors used implied volatilities from the Chicago Board of Option Exchange's Volatility Index and Germany's DAX Equity Index as a proxy for uncertainty in equities markets. Total daily return on the government bond indexes for bonds with maturities greater than ten years from 2 March 1994 to 19 September 2003 were used. The finding from the study is that the stock and bond market integration has trended downwards towards zero and even into negative territory in most European markets. This observation is consistent with findings from other studies which provide evidence supporting the validity of a flight-to-quality phenomenon.

In conclusion, the above literature reviewed is in consensus of evidence of a positive correlation between equity and bond markets. However, during times of crisis or uncertainty within equities markets, the two markets ‘decouple’, resulting in a negative correlation as investors seek the liquid and safer assets within the bond market.

Dungey, McKenzie and Tambakis (2009) specified a threshold auto-regression conditional heteroskedasticity model (TARCH) to test for sign bias in the effect of negative return shocks in emerging stock markets on US Treasury bond yield volatility. They proposed that negative shocks in the returns from developing equity markets should lead to significant positive volatility responses in US Treasury bond yields. They developed specifications to test the hypothesis for a range of maturities in US Treasury bonds, corresponding to a range of emerging equity markets. Their results tended to find evidence in support of their proposition in all but the longest dated US Treasury debt instruments in their study. These findings supported their theoretical model of a flight-to-quality between emerging stock markets and US Treasury bonds.

(iii) Methodology

The most common methodology in the flight-to-quality literature is to investigate whether there is a negative relationship between government bond prices and equity returns in order to find evidence of funds moving rapidly from a domestic equity market into domestic Government bonds.

The following model is specified:

$$\%\Delta BY_t = \alpha + \beta_0 R_{m,t} + \varepsilon_t \qquad (5)$$

The dependent variable $\%\Delta BY_t$ is the per cent change in bond yields from day t-1 to day t, that is from the day before to the day after. The pricing convention in the Australian market for Treasury bonds is in yields. Negative values of $\%\Delta BY_t$ therefore indicate an increase in the bond’s price.

The intercept α represents the average difference between daily yield changes and equity market returns. Although it is reported, it is not of any interest in the context of this study.

The independent variable $R_{m,t}$ is the return on the domestic equity market between day t-1 and day t. A negative value of $R_{m,t}$ implies a fall in the equity market index between yesterday and today.

Following Gulko’s (2002) methodology, a crash day is defined as a day where the market index loses five percent or more of its value.

Equation (5) is estimated three times;

- once for observations falling in the *event window*. The event window is as starting two days before this day and finishes ten days after this day. If another crash occurs between the crash day and day ten after the crash, day ten is reset to occur ten days after the latest crash;

- once for observations falling in the *prologue*. The prologue is defined is defined as ten days before the event window; and

- once for the *epilogue* (the period after the event window) is defined as the ten days after.

The event window is defined as starting two days before this crash day and finishes ten days after this crash day. If another crash occurs between the crash day and day ten after the crash, day ten is reset to occur ten days after the latest crash. The *prologue* is the period before the event window while *epilogue* is the period after the event window. We have also altered the duration of these windows to test the robustness of the estimates.

Hypothesis (i)

In equation (5), β *is significantly negative during the prologue and epilogue, but significantly positive during the crash window.*

(iv) Data

The All Ordinaries (non-accumulation) price and 10-year Australian Commonwealth Government bond yield indices were sourced from Bloomberg. Each observation represents the last trading day closing observation available. The full set of daily observations covers the period from 30 September 1983 to 25 January 2013.

Daily bond yield changes were calculated using the continuous[1] daily percentage change:

$$\%\Delta BY_t = \ln\left(\frac{y_t}{y_{t-1}}\right) \tag{6}$$

where y_t is the last closing yield available on trading day t.

Daily market returns (ie the daily percent change in price) are calculated as:

$$R_{m,t} = \ln\left(\frac{p_t}{p_{t-1}}\right) \tag{7}$$

where p_t is the last closing index price available on trading day t.

Table 9 shows that across the whole period of 7,650 observations on average, daily market returns were positive at 0.025 per cent (prices tended to increase each day), where as bond yields tended to decline over the same period (- 0.019 per cent).

The largest negative daily market return was around 29 per cent, whereas the largest daily gain was only around 6 per cent. Bond yields are more symmetric in their extremes with daily change maximum and minimums being in the order of -7.5 and 7.5 percent respectively.

[1] Continuous per cent changes are preferred in regression analysis due to their symmetrical properties in increases and decreases.

Table 1

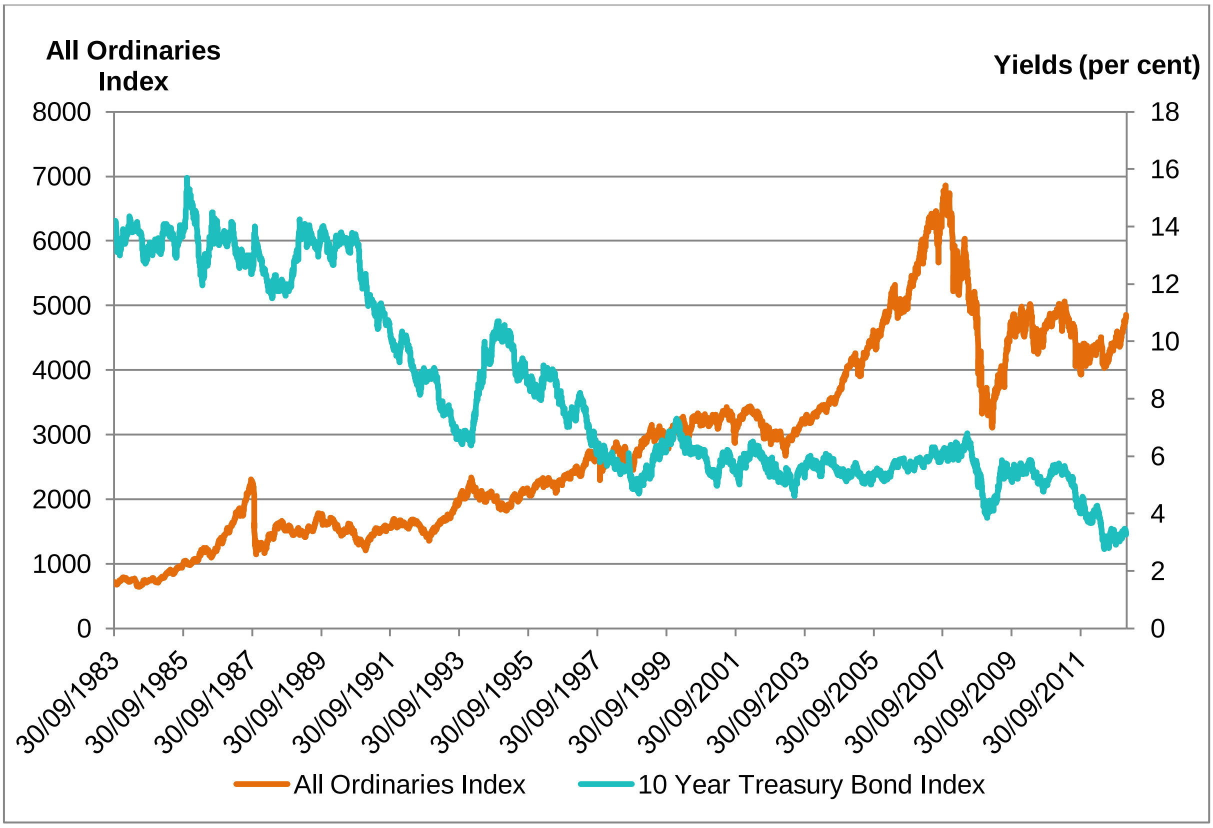
Descriptive Statistics - Full Data Set: September 1983 to January 2013

	Market Return	Bond Yield Change
Mean	0.025%	-0.019%
Mean t-statistic	2.21	-1.51
Median	0.028%	0.000%
Mode	0.000%	0.000%
Standard Deviation	0.989%	1.100%
Range	34.830%	15.038%
Minimum	-28.761%	-7.398%
Maximum	6.069%	7.640%
Sum	191%	-145%
Count	7650	7650

The behaviour of the changes in the series are reflected in the market index and bond yield trends plotted in Figure 7 below. Over the entire period, the All Ordinaries index has trended up while bond yields have trended down.

Figure 7

Australian Stock Market and Treasury Bond Index Trends: September 1983 to January 2013



As per Gulko's study, three subsets of data were extracted from the full set consisting of:

- the crash period;
- prologue period (period before the crash); and
- epilogue (period after the crash).

A crash is defined as any day where the index loses more than 5 per cent of its value. The crash period is defined as that day, the two days before that day and ten days after that day making a crash period thirteen days long, provided another crash did not occur within the crash period. If another crash did occur within a crash period, then the period is extended to include another ten days after that crash and so forth.

The prologue period is defined as the ten days before a crash period while the epilogue is defined as ten days after the crash period. The dates corresponding to the crash are outlined in Table 2 below:

Table 2

Australian Equity Market Crash Dates and Descriptions

Date	All Ordinaries Index	10 Year Treasury Bond Yield Index	Market Return	Bond Yield Change	Event
20/10/1987	1549	13.75	-28.76%	4.46%	1987 Wall Street Crash
23/10/1987	1514	13.3	-7.30%	0.00%	
26/10/1987	1415	13.1	-6.78%	-1.52%	
27/10/1987	1317	13.5	-7.20%	3.01%	
29/10/1987	1284	14	-7.82%	2.53%	
4/11/1987	1290	13.65	-5.63%	0.00%	
16/10/1989	1601	14.002	-8.44%	0.00%	United Airlines Leveraged Buy Out Failure
28/10/1997	2299	6.045	-7.45%	4.22%	Asian Financial Crisis
17/04/2000	2920	6.098	-5.85%	-1.51%	'Dot Com' Bubble
22/01/2008	5222	5.872	-7.54%	-2.62%	Global Financial Crisis
8/10/2008	4370	4.931	-5.09%	-2.58%	
10/10/2008	3940	5.139	-8.55%	0.98%	
16/10/2008	3988	5.248	-6.89%	-2.35%	
13/11/2008	3672	4.909	-5.59%	-3.50%	

October 1987 witnessed one of the most spectacular stock market crashes on record as stock exchanges worldwide recorded some of the largest one day declines in history. While there is no consensus to its cause, some factors considered to contribute to the cause include widespread contagion, a lack of liquidity and an extended period of overvaluation in stock prices prior to the crash.

The October 1989 crash was triggered by the breakdown of the United Airlines leveraged buyout. The breakdown of the United Airlines buyout triggered a collapse in the junk bond market as the announcement that the buyout group could not secure the requisite amount of debt financing caused widespread contagion as investors withdrew their money from the equity and bond markets.

The October 1997 crash was triggered by the Asian Financial Crisis which saw large currency depreciations and defaults in many Asian countries. The crisis started in Thailand with the collapse of their sovereign currency, which triggered widespread depreciations in currencies, equities markets and asset price across most of the Southeast Asian nations.

The April 2000 crash was triggered by the popping of the 'dot com' bubble, a speculative bubble in internet stocks within the NASDAQ from 1995 to 2000. The bubble was characterised by overvaluations and irrational exuberance towards internet based stocks which was started by rapidly increasing stock prices, overconfidence and widely available venture capital for internet based stocks.

The 2008 stock market crash was caused by the onset of the 2008 Global Financial Crisis. This crisis was triggered a combination of the United States subprime mortgage crisis, the effect of which was spread worldwide by securitisation causing a liquidity crisis in the credit market. This eventually caused the bankruptcy of many major financial institutions, such as Lehman Brothers, Fannie Mae, Freddie Mac and Bear Stearns.

Descriptive statistics for the 108 observations falling in the crash periods are outlined below. Daily market returns in this period are significantly negative on average as expected, while daily changes in bond yields are also negative on average, although these changes appear not to be significantly different from zero as indicated by the mean t-statistic, median change and sum of changes. The major changes in stock returns (minimum of bond yields (minimum of -7.398 per cent and and maximum of 7.640 per cent) and bond yields (minimum of -28.761 and maximum of 6.069 per cent) from the full data set are incorporated within the crash period set.

Table 3

Australian Equity Market Crash Period Data Set

	Market Return	**Bond Yield Change**
Mean	-0.879%	-0.067%
Mean t-statistic	-2.11	-0.35
Median	-0.256%	0.000%
Mode	0.000%	0.000%
Standard Deviation	4.322%	1.971%
Range	34.830%	15.038%
Minimum	-28.761%	-7.398%
Maximum	6.069%	7.640%
Sum	-95%	-7%
Count	108	108

Source: Bloomberg

Prior to the crash, descriptive statistics (Table 4) based on the 70 observations show that the average change in both series are of the same sign, but not of a large magnitude. The ranges and volatility of these series (as shown by the standard deviation) appear to be more closely aligned than during the crash period above.

Table 4

Descriptive Statistics - Prologue Data Set

	Market Return	Bond Yield Change
Mean	-0.182%	-0.099%
Mean t-statistic	-0.92	-0.54
Median	-0.234%	0.000%
Mode	NA	0.000%
Standard Deviation	1.651%	1.524%
Range	9.059%	9.448%
Minimum	-4.391%	-4.848%
Maximum	4.668%	4.600%
Sum	-13%	-7%
Count	70	70

Source: Bloomberg

In the period after the crash, descriptive statistics in table 5 below show a similar situation to that in prologue. The average change in both series is of the same sign, but not of a large magnitude while the ranges and standard deviations are more aligned than those in the crash.

Table 5

Descriptive Statistics - Epilogue Data Set

	Market Return	Bond Yield Change
Mean	-0.186%	-0.145%
Mean t-statistic	-0.88	-0.80
Median	-0.192%	0.000%
Mode	NA	0.000%
Standard Deviation	1.777%	1.520%
Range	10.259%	8.773%
Minimum	-5.592%	-4.438%
Maximum	4.668%	4.335%
Sum	-13%	-10%
Count	70	70

Source: Bloomberg

The overall picture from these statistics is that daily changes in bond yields tend to respond mildly to crashes in the stock market, but these changes appear to behave in a comparable way to stocks returns.

(v) Results

Equation (5) was run on the full data set and the subsets, prologue, crash and epilogue to test Hypothesis (i). The three components of the hypothesis are rejected:

- The beta regression coefficient in the prologue subset is significantly *positive* – the hypothesis requires it to be significantly *negative*.

- Beta is not significantly different from zero during in the crash subset – the hypothesis requires it to be significantly positive.

- Beta in the epilogue is significantly *positive*
– the hypothesis requires it to be significantly *negative.*

Table 6

Regression Results

Period	Beta	p-value	R-square	Observations
Full Set	0.0789	0.0000	0.0050	7,650
Prologue	0.4614	0.0000	0.2499	70
Crash	-0.0040	0.9277	0.0001	108
Epilogue	0.4315	0.0000	0.2545	70

Source: Bloomberg

The full data set estimate is positive and significant at 1 per cent. This indicates that over the whole period, bond yields tend to change in the same direction as stock prices. Another interpretation is that bond prices tend to change in the opposite direction of stock prices over the whole period. This relationship appears to move closer towards a one to one co-movement during the prologue, disappears entirely during the crash and returns toward a one to one co-movement after the crash.

(vi) Conclusion

The 'flight-to-quality' hypothesis as formulated by Gulko is rejected in the Australian Market. The results from this study suggest that, in general, there tends to be some positive co-movement between stock prices and Treasury bond yields in Australia. In the days before a crash, it appears that the co-movement is more direct between the two markets, but this co-movement completely breaks down during the days that closely surround a crash. In the epilogue, similar co-movement between the markets appears to return. We have also altered the duration of the windows to test the robustness of the estimates and the same conclusions are achieved.

Gulko's analysis was carried out on the US market. The US is perceived as a 'safe haven' thus it may experience net capital inflows from the rest of the world into its safest assets (Caballero & Kurlat 2008). Post 1987, the US Treasury bonds became the safe investment of choice over gold.[2] Conversely, Australia is a very small market without the reputation of the US as a safe haven during times of heightened uncertainty. A possible explanation for the above results is that the 'flight-to-quality' effect may see funds leaving the Australian market destined for investment in markets that are perceived as safe. Dungey, McKenzie and Tambakis' 2009 study found this to be the case between emerging equity markets and the US Treasury bond market.

(IV) A co-integration between the market risk premium and a risk-free rate of return?

This empirical estimate is conducted in response to the view that there is a negative relationship between the market risk premium and a risk-free rate of return. As such, it is argued that any reduction in the risk-free rate will be offset by an increase in the MRP, leaving a return on equity unchanged. The view of the inverse relationship between the risk-free rate and the MRP is identical to the view that they are co-integrated. An analysis is conducted to test this hypothesis on the co-movement between the risk-free rate and the MRP.

(i) Methodology

A single time series such as the yields on a bond may move in such a way that it does not revert to any long run mean or long run level of volatility. In the language of time series analysis, such a series is known as *non-stationary*. The implication is that the most recent observation in the series is the best predictor of tomorrow's value.

Two or more time series that exhibit such trends can at times have a stochastic trend in common - often exhibited over long periods of time. It can be the case that a linear combination of the two series produces a new stationary series, that is, one that tends to revert to some long run average and long run level of volatility. This implies that an equilibrium relationship exists between the series. Two series that exhibit such a characteristic are referred to as *co-integrated*.

In the case of the market returns and the risk free rate in the CAPM, the two series are tested to confirm whether or not they are co-integrated, in the sense that they share some long run stochastic trend. Intuitively, the risk free rate is not expected to rise above the market returns for an extended period of time. Conversely, the market returns is not expected to stay below the risk free rate for an extended period of time. One would expect a tendency for correction over the long run where the returns to investing in the market are sufficiently higher than risk free rate to compensate for the risks inherent in equity investment.

The following series is constructed:

$$\varepsilon_t = R_{m,t} - \phi Yield_t \qquad (8)$$

where $R_{m,t}$ is the market return, $Yield_t$ is the corresponding bond yield on day t. The initial assumption is that phi (ϕ) is equal to one.

Series (8) is tested for stationarity using the Dickey-Fuller Generalised Least Squares test. The following hypothesis is tested:

Hypothesis (ii)

The series are non-stationary - that is they have a unit root.

Additionally, tests are carried out to relax the assumption that ϕ is equal to one using the two step Engel-Granger Augmented Dickey Fuller test for cointegration.

The first step involves running the following regressions:

$$R_{m,t} = \alpha + \phi Yield_t + \varepsilon_t \qquad (9)$$

$$MRP_{m,t} = \alpha + \phi Yield_t + e_t \qquad (10)$$

The second step involves using the Augmented Dickey-Fuller test on residual series ε_t and e_t to test hypothesis (ii).

(ii) Data

The daily (trading day) annualised bid yield (Yield) on 5-year and 10-year Australian Government Bonds and daily closing price for the All Ordinaries accumulation index were sourced from Bloomberg. The last available price[3] is used for each trading day observation on all data series. The data is outlined in Table 7 below.

Table 7

Market Index and Bond Yield Raw Data: Acquired January 2013

Description	Ticker	Source	From	To	Observations
10 Year Australian Government Bond	GACGB10	Bloomberg	7/04/1989	23/01/2013	7,195
5 Year Australian Government Bond	GACGB5	Bloomberg	19/03/1991	23/01/2013	6,688
All Ordinaries Accumulation Index	ASA30	Bloomberg	7/04/1989	23/01/2013	7,195

The yields of government bonds are plotted below in Figure 8 to illustrate the trends over time.

[3] Bloomberg field 'PX_LAST'.

Figure 8

Australian Commonwealth Government Bond Index Series 5 Year versus 10 Year 1989 to 2013

Market returns were constructed for a 5-year and 10-year holding period by taking the natural log of the last closing price for 5 calendar years (or 10 for 10 year period) in the future divided by the present day's closing price. This continuous return is annualised by dividing by 5 for 5-year holding period (or 10 for 10-year holding period).

$$R_{m,t} = \ln\left(\frac{P_{t+5years}}{P_t}\right)/5 \tag{11}$$

where P_t is the last available daily closing price on day t.

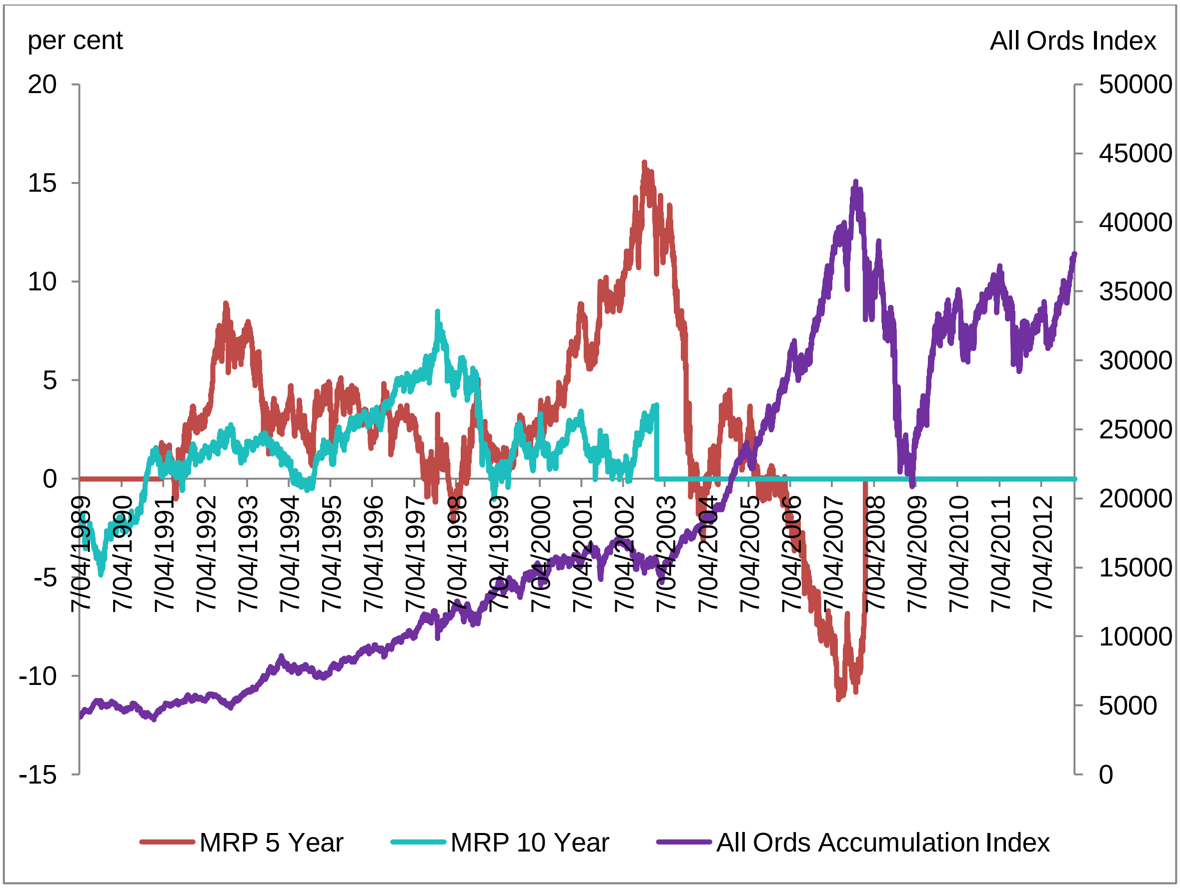
The market risk premium is calculated by subtracting the present day's yield from the present day's return calculated in (11). This is done for both the 5 and 10 year series.

$$\text{MRP}_t = \ln\left(\frac{P_{t+5years}}{P_t}\right)/5 - \text{Yield}_t \tag{12}$$

The resultant series from (12) for 5-year holding period and 10-year holding period is illustrated in Figure 9.

Figure 9

Market Risk Premium - Holding Period of 5 Years versus 10 Years - 1989 to 2013



(iii) Results

The Dickey-Fuller GLS unit root tests were carried on the series constructed from (8) assuming ϕ equal to one for both the 5-year and 10-year series. The results are shown in Table 8 below.

Table 8

Dickey-Fuller GLS Unit Root Tests: No Trend or Drift - ϕ = 1

Series	Observations	Test Statistic	Critical Value			Stationary
			1%	5%	10%	
5-Year Series	4,861	-1.3680	-2.57	-1.94	-1.62	No
10-Year Series	3,601	-0.7200	-2.57	-1.94	-1.62	No

The hypothesis that the series have a unit root cannot be rejected even at the 10 per cent level of significance. This suggests that in both the 5-year and 10-year series, the market return and bond yield are *not* co-integrated. This conclusion implies that there is *no* long run equilibrium relationship between the two series observed over the period in which these observations are taken.

Before running regression (9) and (10) to test the residuals, Augmented Dickey-Fuller tests were carried out to determine whether the risk free rate and the market return series alone were stationary. A trend was included in the test on the basis of the distinct declining trend exhibited over the periods in which all series were observed. The results are presented in Table 9.

Table 9

Augmented Dickey-Fuller Tests on Market Returns and Bond Yield Series with trend

Series	Observations	Test Statistic (tau)	Critical Value 1%	5%	10%	Stationary
5 Year Bond Yield Index	4861	-2.8053	-3.96	-3.41	-3.12	No
5 Year Market Returns	4861	-1.9297	-3.96	-3.41	-3.12	No
10 Year Bond Index	3601	-2.0686	-3.96	-3.41	-3.12	No
10 Year Market Returns	3601	-2.2897	-3.96	-3.41	-3.12	No

All of the tests do not reject the hypothesis of a having a unit root as demonstrated by the low values of the test statistics relative to the critical values in absolute terms.

Augmented Dickey-Fuller unit root tests were carried out on the residual series ε_t and e_t from regression (9) and (10) with the results presented in Table 10 below.

Table 10

Augmented Dickey-Fuller Unit Root Tests: No Trend or Drift - ϕ unconstrained

Series (Regression)	Observations	Test Statistic (tau)	Critical Value 1%	5%	10%	Stationary
5 Year Series (2)	4,861	-1.3424	-2.58	-1.95	-1.62	No
5 Year Series (3)	4,861	-1.3424	-2.58	-1.95	-1.62	No
10 Year Series (2)	3,601	-2.2600	-2.58	-1.95	-1.62	Yes
10 Year Series (3)	3,601	-2.2660	-2.58	-1.95	-1.62	Yes

Again, the 5-year series did not reject the hypothesis of no unit root as shown by the value of the test statistic being lower than even the value 10 per cent critical value in absolute terms.

The 10-year series however, rejected the hypothesis of a unit root at the 5 per cent level of significance. This suggests that the 10 year risk free rate and market returns/risk premium are co-integrated with the implication that a long term equilibrium relationship exists between them.

The regression results for (9) and (10) on the 10 year series are shown in Table 11.

Table 11

10-Year Yield Series Regression (9) and (10) Results

Regression	Observations	Intercept (alpha)	Yield Coefficient (phi)	R-Squared
10 Year Series (2)	3,601	6.3702	0.4222	0.2896
p-value		0.0000	0.0000	
10 Year Series (3)	3,601	6.3702	-0.5778	0.4329
p-value		0.0000	0.0000	

The intercept for both cases is highly significant at 6.37 per cent annualised return. The yield coefficient ϕ (known as the cointegrating coefficient) indicates a positive relationship between returns and the risk free rate. The sign of this result is intuitively appealing, given we expect that market returns consist of some premium over the risk free rate; market returns tend to rise when the risk free rate rises and vice versa. There is no obvious reason in practice however, why the coefficient should not equal one. Conversely, ϕ indicates a negative relationship between the market risk premium and risk free rate series.

These coefficients should be interpreted with caution. In addition to the nonsensical value of ϕ in (9) generally, these Ordinary Least Squares (**OLS**) estimates have a non-normal distribution meaning inference based on the student distribution can be misleading. While dynamic OLS estimates can resolve this latter issue, one would expect to see a value of one on the yield coefficient in regression (9).

(iv) Conclusion

There is no evidence to support a cointegrating relationship between the 5-year bond yield series and market return/risk premium series. Statistically, there appears to be a cointegrating relationship between the 10-year bond yield series and the corresponding market return/risk premium series when the cointegrating coefficient (ϕ) is not constrained to one. One must exercise caution in accepting the conclusion in the unconstrained analysis given the estimate for the coefficient on bond yields regressed against market returns is much less than one. From economic theory, common sense is relied up when carrying out cointegration tests. The estimate of -0.5778 for the cointegrating coefficient ϕ does not make economic sense because the MRP is considered as the market return less the *entire* risk free rate not *some proportion* of it (Stock & Watson 2007).

(V) Overall conclusions

In this paper, a possible relationship between a risk-free rate of return and a MRP has been considered on both theoretical grounds and empirical grounds.

On theoretical grounds, we consider that there are three possibilities for this relationship between the two parameters: (i) negative relationship; (ii) positive relationship' and (iii) a reduction in a risk-free rate is associated with unchanged MRP.

On empirical grounds, our empirical studies did not support the view that any reduction in the risk-free rate is offset by an increase in the MRP. The small, open, dynamic Australian financial market is constrained by various factors, not only stocks and bonds. Empirical evidence could not support the flight to quality in the Australian financial market. We are not aware of any empirical studies which indicate there is such a flight in the Australian financial market in recent periods.

We are not convinced that there is a negative relationship between the MRP and a risk-free rate of return. Available evidence indicates that this relationship can occur in either direction. Our empirical studies have failed to find statistical evidence that there is a co-integration in the Australian financial market. As a result, a constant return on equity cannot be supported on both theoretical and empirical grounds. On balance, a scenario which indicates a possibility that a reduction of a risk-free rate of return is not associated with any move in the MRP is the most appropriate. This view is not only supported by our empirical studies, but also supported by observed data on the implied volatility, which is a proxy for a level of risk aversion in the financial market.

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