Australian Superannuation SRI Funds: A Study on Systematic Risk using Markov Switching

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EXTENDED ABSTRACT

A growing attention of Australian superannuation funds invested in socially responsible investments (SRI). Existing studies show that SRI funds perform similarly to non-SRI funds. However, these studies have mainly focused on a comparison of returns. This study examines the sensitivity of Australian superannuation SRI funds to movements, in terms of the extent, speed and duration, in equity market and SRI sectors of Australia and the US. We perform the analysis by taking into account the different market conditions through the application of Markov regime switching approach. Our results reveal that the Australian superannuation SRI funds are driven by the US and Australian equity markets, with the US market being the dominant influence. Similarly, Roca and Wong (forthcoming) reached the same conclusions with regards to Australian superannuation non-SRI funds. Thus, Australian superannuation SRI funds are also driven in the same way by the US and Australian equity markets. We have, however, additionally found that Australian superannuation SRI funds are also driven by the SRI sector – in the US but not in Australia. This implies that the US SRI sector is also a source of systematic risk for Australian superannuation SRI funds.

1. INTRODUCTION

Australia is the largest market in the Asian region and it is one of the world leaders in terms of socially responsible investments (SRI) policy initiatives. Strong interest among investors and financial professionals has driven the growth of the SRI market in Australia. Over the past decade, SRI funds experienced tremendous growth in the most developed economies around the world. The managed SRI portfolios grew by 70 percent from A$4.5 billion to A$7.67 billion in June 2004 to June 2005 (Social Investment Forum, 2005). Thus, given the increasing large amount of funds being placed in SRI, there is a greater need to understand the risk involved in these investments, particularly more so in the case of retirement or superannuation funds.

Most of the existing SRI empirical studies focus on fund performance and compares performance against non-SRI funds. For instance, Hamilton *et al*. (1993) and Statman (2000) studied US SRI funds; Luther *et al*. (1992) and Gregory *et al*. (1997) examined UK SRI funds; Bauer *et al*. (2007) studied Canadian SRI funds; Bauer *et al*. (2006) analysed Australian SRI funds; and Kreander *et al*. (2005) and Bauer *et al*. (2005) examined international SRI funds. These studies have generally come to the conclusion that SRI funds, including Australian superannuation funds, do not perform differently from non-SRI funds. None of these studies, however, have focused on the systematic risk or sensitivity to market movements of SRI funds.

The magnitude of systematic risk of Australian SRI superannuation funds under different market conditions or regimes provides an indication of the market timing skills of these funds, in which fund managers may practice tactical asset allocation. During up market conditions, funds should gain maximum exposure to the market in order to benefit from this situation while during down markets, they should minimise their exposures. Therefore, this implies that during up market conditions, funds' beta or systematic risk should be positive and greatest while during down market conditions, this should be smallest, if not negative. Considering the importance of systematic risk, most especially with respect to retirement or superannuation funds, we address this gap in the literature.

While these studies mainly focused on comparing the risk and returns of SRI funds with conventional funds, none of them have particularly examined the systematic risk of SRI funds that vary according to regimes. We analyse this issue with respect to Australian superannuation SRI funds where the issue would be of utmost importance. We investigate the extent, speed and duration of the response of Australian superannuation SRI funds to the movements in the equity market and SRI sectors in the US and Australia based on the Markov regime switching methodology. One of the major advantages of this approach is that it does not require prior specifications or dating of funds returns' regimes. Instead, regimes and their corresponding probabilities of occurrence are endogenously determined by the model. Thus, the use of the Markov switching model allows a more robust and informative analysis on the sensitivity of Australian superannuation SRI funds to market movements. We then compare the results of our analysis of the sensitivity to market movement of Australian superannuation SRI funds to that of their non-SRI counterparts as reported in Roca and Wong (forthcoming), which were also based on the use of a similar methodology.

The remaining parts of this paper are organised as follows. Section two discusses the methodology and data used in the study. Section three presents the empirical results of the study followed by the conclusion in section four.

2. METHODOLOGY AND DATA

2.1. Methodology

In this paper, we regressed the SRI funds' returns against the returns on the Australian and US markets. Each coefficient varies or switches across different regimes and they will have a value for each regime – i.e. one for the "up, normal and down regime". We do this through the use of the Markov regime switching model based on the work of Krolzig (1997). The regimes are identified by the model. The probability of occurrence (called regime probability) as well as the duration of each regime is also determined. In addition, the probability of switching to another regime when one is in a certain regime is identified. This so-called "transition probability" provides another indication of the volatility of a certain regime. We also decompose each coefficient to trace the co-movement of fund returns with each of the markets based on impulse response analysis (see Ehrmann *et al*, 2001, pp. 10-11).

All analyses are performed within the context of a Vector Autoregression (VAR), which involves multivariate and simultaneous system of equations (see Sims, 1980). In this study, we therefore consider VAR models with changes in regime (Markov switching-VAR). In the most general specification of an MS-VAR model, all parameters of the VAR are conditioned on the state s_t of the Markov chain. Denoting the number of regimes by m and the number of lags by p and the observed time series vector y_t , the MS-VAR model of this study can be represented as follows:

$$y_t = \begin{cases} v_1 + B_{11} y_{t-1} + \ldots + B_{p1} y_{t-p} + A_1 u_t & if\ s_t = 1 \\ \vdots & \\ v_m + B_{1m} y_{t-1} + \ldots + B_{pm} y_{t-p} + A_m u_t & if\ s_t = m \end{cases}$$

where $y = [y_1, y_2, y_3]'$; y_1 is the returns on SRI funds'; y_2 is the returns on Australia market; y_3 is the returns on US market; v represent the regime-dependent intercept term; B is the parameters shift functions; s_t is assumed to follow the discrete time and discrete state stochastic process of a hidden Markov chain; u_t is the vector of fundamental disturbances, is assumed to be uncorrelated at all leads and lags:- $u_t \sim NID(0, I_K)$; K is the dimension of the coefficient matrix A (i.e. it describes the number of endogenous variable).

Two set of equations are estimated in this paper; one equation is based on the Dow Jones Sustainability Index (DJSI) to represent the Australian and US markets, while the other equation is based on the Dow Jones Total Market (DJTM). The rationale of using two indexes is to determine the sensitivity of SRI funds to its "sustainable" sector benchmark and a benchmark for the equity market in general. We would like to find out whether the US and Australian equity markets drive Australian superannuation SRI funds returns. In addition, we also want to investigate whether, indeed, there is such a sector or industry as a "sustainable" sector or industry, which should then be a source of systematic risk. If there is, then the funds should be significantly affected by the DJSI benchmark. Details of the data are discussed in the next section.

In order to determine the appropriate Markov switching model to use, we conduct a number of diagnostic tests. We test the data for unit roots and hetersoskedasticity. We also test for the optimal number of regimes and number of lags for the model. After we have determined the specific form of the MS model, we then estimate the model based on the procedures developed by Krolzig (1997). Subsequently, we conduct an impulse response analysis using Choleski decomposition method (see Roca and Wong (forthcoming) for further explanation).

2.2. Data description

This study covers the period from February 1996 to December 2005. We chose this period due to the completeness of data and its richness with financial market events such as, the Asian crisis and the surge in US bond prices in 1997, Russian crisis in 1998, Dotcom boom in 1999 followed by its collapse in 2000, September 11 attacks in 2001, Enron bankruptcy in late 2002, and the Worldcom and Delphia bankruptcy in 2003. This study utilises weekly data in order to avoid noise, non-synchronous trading and the day of the week effects associated with daily data. There are 570 weeks during the study period. Data is collected every Thursday of the week. In the case when Thursday data is not available, Friday data is used.

The Australian SRI funds data used in this study are supplied by Morningstar. All funds included in this analysis are represented in the database during the whole period of study, thereby, avoiding the survivorship bias problem created when funds, which do not survive for the full sample period, are absent from the database. After the process of filtering, 90 funds are left and these funds are then used in this study.

This paper also utilises the Dow Jones Sustainability Index (DJSI) and Dow Jones Total Market (DJTM) data for Australia and the US markets. The DJTM index is based on float adjusted market capitalisation and firms included in the index are weighted according to their size and industry in the market. DJSI is one of the world's first socially responsible indexes and remains the first index seeking to track the performances of leading sustainability firms on a global basis. A major strength of DJSI is that it is one of the only SRI indexes that is fully and regularly audited and verified by the independent auditors (DJSI, 2005). The DJSI derives its investment universe from the DJTM with both indexes employing the same methodology for calculating, reviewing and publishing their indexes. The full integration of the two indexes enables a direct comparison of each index's characteristics, whilst allowing for a direct comparison of their relative risks and performance (Beloe *et al*, 2004). The DJTM index consists of 1,606 companies in the US and 270 companies in Australia, out of which 58 US companies and 18 Australian companies are included in the DJSI index.

3. EMPIRICAL RESULTS

3.1. Diagnostic Test Results

To test for unit roots in each of the returns time series, this study performed the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests. The null hypothesis of non-stationarity (unit root) and alternative hypothesis of stationarity (no unit root) are tested for each data series, in its original form. The findings are not reported but are available upon request. The ADF and PP tests reject the null hypothesis of a unit root at 5% level of significance. Both unit root tests suggest the data are stationary. Consequently, the returns time series will be used in the subsequent analysis without further differencing or testing for cointegration.

The next step in deciding the appropriate Markov switching model is to test for the existence of heteroskedasticity, which is performed using the White's test. The null hypothesis of no heteroskedasticity against heteroskedasticity of some unknown general form is tested. The results show a Chi-square 498.6686 corresponds to 300 degrees of freedom with a p-value of 0.0000. Thus, the null hypothesis is rejected which suggests that the data contain heteroskedasticity. Subsequently, the study applies the Markov switching MSIAH(m)-VAR(p) model.

To determine the optimal number of regimes and lags to be used in the MS model, we tested 2 to 4 regimes and 1 to 4 lags with the Schwarz Information Criterion (SIC). The results show that the lowest SIC value corresponds to the Markov regime switching model with 2 regimes and 1 lag for the DJSI and DJTM models. Hence, this study adopts the Markov switching MSIAH(2)-VAR(1) model. Roca and Wong (forthcoming) have found 3 regimes in their study on conventional funds. However, we believe that SRI funds are a specific niche of the market and hence it would have fewer regimes. Several other studies have used Markov switching 2 regime model in capturing market cycles and forecasting future market condition and found to have performed well (see, Schaller and van Norden, 1997; Humala, 2005).

3.2. Regime and Transition Probabilities

Based on Table 1, regime 1 is the higher volatility regime and regime 2 is the one with the lower volatility. This applies to both the equity market (DJTM Model) and the SRI sector (DJSI Model). The volatility of regime 1 is lower for the former than the latter but it is the opposite when it comes to regime 2. However, the returns for regime 1 are higher for the former (DJSI) than the latter (DJTM). In fact, there are negative average returns for regime 2 in the DJTM model. Thus, it seems that the traditional risk-return relationship (i.e. lower return for a lower risk) does not apply to the SRI funds.

Regime 1 captures 76.8% of the observations for equity market and 70.2% for the SRI sector. Regime 1 also has a much longer duration than regime 2 for both the equity market and SRI sector. However, each regime lasts longer for the SRI sector than for the equity market. This implies that there is less switching between regimes for the former than the latter. There is therefore more regime stability in the funds relationship with the SRI sector than with the equity market.

Table 1. Characteristics of Each Regime.

	DJSI Model		DJTM Model	
Regime	1	2	1	2
Probability (%)	70.2	29.8	76.8	23.2
Duration (weeks)	41.2	17.5	16.1	4.9
Observations	360.5	156.5	396.8	120.2
Average Returns	13.5	15.4	22.1	-17.5
Average Volatility	3.1	1.5	2.7	2.5

As for the transition probabilities, the probability of staying within the same regime is very high for both the equity market and SRI sectors. For the equity market, the probability of remaining in regime 1 is 93.78% as compared to 79.42% in regime 2. These probabilities are even higher for the SRI sector (97.57% for staying in regime 1 and 94.28% for staying in regime 2). Thus, this supports our previous observation that there are fewer switches between regimes in the SRI sector. The relationship of the Australian superannuation SRI funds with the SRI sector is therefore characterised by more regime stability than their relationship with the equity market.

A graphical representation of the regime probabilities is shown in Figures 1 and 2. By simple inspection, the probabilities for regime 1 are much bigger than that of regime 2, thus confirming the previous statement that most observations occur in regime 1. It is also quite obvious that there are fewer spikes in the DJSI graph (Figure 1) as compared to the DJTM graph (Figure 2). This is further evidence that there is less switching for the SRI sector (DJSI Model) as compared to the equity market (DJTM).

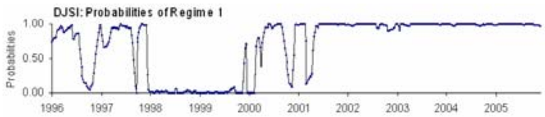

Figure 1. Regime 1 probabilities for DJSI model. The probabilities of Regime 2 are opposite of this.

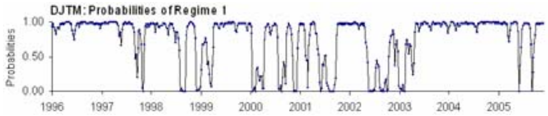

Figure 2. Regime 1 probabilities for DJTM model. The probabilities of Regime 2 are opposite of this.

For the DJSI model (SRI sector), the regime switches occurred only mostly during the period between 1996-1998 and 2000-2001. Most observations remained mainly in regime 2 during the period 1998-1999 and in regime 1 during the period 2002 until the end of the study period. In contrast, for the DJTM model (equity market) regime switches were very evident during the years 1997, 1998-1999, 2000-2001, 2002-2003 and 2005. These spikes or switches in equity market correspond to periods of financial distress (as mentioned in section 2.2). These events mostly occurred in the US, thus implying that the US market could have a major impact on Australian funds' returns. Hence, the result here could explain the negative returns shown in Table 1, of which Roca and Wong (forthcoming) obtained similar results with respect to the relationship of Australian non-SRI superannuation funds with the US and Australian equity market. As such, Australian superannuation SRI funds do not differ with their non-SRI counterparts in terms of regime stability in their relationship with the US and Australian equity markets.

3.3. Regime Coefficients

The estimated parameters of the Markov switching model are presented in Table 2, which provides information on the sensitivity of SRI funds' returns to the movement in Australian and US markets in each regime in the DJSI and DJTM models. The coefficients of the US market are statistically significant in all regimes for both models; however, the only coefficients that are statistically significant for the Australian market are those corresponding to regime 1 in the DJTM model. These coefficients are statistically significant and are all positive, indicating that SRI funds' returns would move in the same direction with these markets.

Table 2. Estimated Coefficients. Note: * 5% significance level. Model based on 1 lag

	Regime 1	Regime 2
DJSI Australian	0.0713	0.0367
DJSI US	0.1759 *	0.2510 *
DJTM Australian	0.2588 *	-0.2192
DJTM US	0.1522 *	0.3360 *

The Australian DJSI does not significantly affect the returns of the Australian superannuation SRI funds in any regime. This implies that the Australian SRI sector is not a source of systematic risk for the Australian superannuation SRI funds. The SRI sector in Australia therefore cannot be considered as exerting some sort of "SRI industry" effect. The US SRI sector, however, significantly drives the returns of Australian superannuation SRI funds. Funds returns were found to be sensitive to the US SRI sector (DJSI) in all regimes most especially during regime 2. This implies that funds returns are more exposed to the US SRI sector during the lower volatility regime. Thus, the US SRI sector is therefore a source of market risk for Australian superannuation SRI funds and can be considered as exhibiting some sort of "SRI industry" factor. A possible explanation for this is that, as mentioned in Section 2.2 of this paper, the US DJSI benchmark consists of a much bigger number of firms (58 in total) as compared to the Australian DJSI (18 only).

As stated previously, the US and Australian equity markets significantly drive the Australian superannuation SRI funds returns. The US equity market influences the funds returns in both regimes but mostly during regime 2 (the lower volatility regime). In contrast, the Australian market only affects the said funds during one regime – in regime 1 (the higher volatility regime). This indicates that the US market is responsible for funds returns movements in all market conditions. It is well documented in the literature that the US stock market drives equity markets worldwide including Australia. Several other studies have found that the US market has a significant influence towards the Australian market (for example, Roca, 1999; Ragunathan *et al*, 2000).

Australian superannuation SRI funds were therefore exposed to the US equity market in all regimes and to the Australian equity market only during the higher volatility regime. If these funds were practicing market timing, then the expectation is that they should be exposed to the equity market during the higher volatility state of the market, as this will provide higher yields. The finding therefore indicates that these funds had more market timing success with the Australian equity market than with the US market. A possible explanation could be due to the inability of SRI fund managers to predict the US market correctly; or if they were able to predict the market correctly, they do not shift their portfolio composition accordingly because of high switching cost, or they are prohibited or restricted from doing so by government regulations as well as by their charters. These results are consistent with Treynor and Mazuy (1966) and Fabozzi and Francis (1979) who found that fund managers did not reduce (increase) the funds' beta in down (up) market conditions to earn higher returns.

3.4. Impulse Response Analysis

Further investigation to analyse the speed and duration of the superannuation funds' returns response to Australian and US markets movements is performed by decomposing the coefficients in each regime (shown in Table 2) through the use of impulse response analysis based on the Markov switching model. The impulse response analysis shows the expected change in the SRI funds' returns after a one standard deviation shock to the Australian and US equity markets and the US SRI sector under the states of funds returns on a weekly basis. Figure 3 presents the impulse response of funds' returns to those markets, which have significant positive coefficients in the Markov switching model, namely the Australian equity market in regime 1 (DJTM model) and the US equity market and SRI sector in regimes 1 and 2 (DJSI and DJTM models) as shown in Table 2.

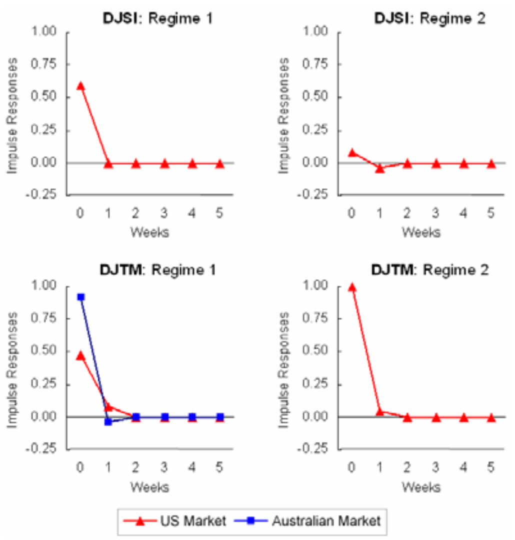

Figure 3. Impulse Response for DJSI and DJTM Model. Only significant coefficients are plotted.

The results of the impulse response analysis show that funds' react to movements in the Australian and US equity markets immediately, within week 1, and complete their response by week 2. During regime 1, funds' returns respond to the Australian equity market (DJTM) immediately in a positive manner, then negatively during week 1 and fades out after the second week. The responses to the US equity market are similar to those to the Australian equity market. The same responses can also be seen with respect to the US SRI sector (DJSI). The responses by the funds to the US SRI sector (DJSI) follow the same pattern but their magnitude is much smaller which means that the funds are less sensitive to the US SRI sector. The responses (to the US SRI sector) in regime 1, however, are completed within a week, indicating that funds' returns are more efficient in regime 1.

As can be seen further in Figure 2, the SRI funds' returns responds to the US equity market movements with the highest magnitude during regime 2 of DJTM model. This implies that funds' returns are most sensitive to the US equity market when funds returns are in a lower volatility state and less sensitive when they are in a higher volatility. Fund managers therefore are most exposed to regime 2 of the US equity market in which returns are negative but least exposed during regime 1 when returns are higher. This provides further evidence that Australian superannuation SRI fund managers may not have the market-timing ability with respect to the US equity market just like their non-SRI counterparts as reported by Roca and Wong (forthcoming).

During the higher volatility regime, funds' returns respond positively to the Australian equity market, which is also completed by week 2 (see DJTM model). This suggests that the Australian equity market would have an impact on funds' returns during higher volatility market condition and fund managers could take advantage of this opportunity for higher returns. The impulse responses, shown in Figure 3, have further confirmed the results presented in Table 2, where the US market is the main influence on the Australian SRI funds' returns under all fund returns regimes.

We stated previously that the responses of funds' returns to the Australian and US equity markets are completed within two weeks time. As this study has utilised weekly data, we consider these responses to be efficient in line with Beechey *et al* (2000) who found efficiency in the price reaction of managed funds and Bracker *et al* (1999) and Roca (1999) who found the same with regards to stock market price response.

4. CONCLUSION

This paper investigates the sensitivity or exposure of Australian superannuation SRI funds to the equity market and SRI sector of Australia and the US. In particular, we examine the extent, speed and duration of response of the Australian superannuation SRI funds' returns to movements in the US and Australian equity markets and SRI sectors under different states or regimes of funds returns. We perform the investigation through the application of the Markov regime-switching model in which an impulse response analysis is also conducted. We then compare our results with those reported by Roca and Wong (forthcoming) who examined the same issues and using similar methodology but focusing on Australian superannuation non-SRI funds.

Our results show that the funds are exposed most to the US equity market during the low volatility regime (where returns were low) rather than during the high volatility regime. The funds are only exposed to the Australian equity market during the high volatility regime. From the point of view of market timing, if indeed the funds were practicing this, it would appear that the funds have less success with the US market than with the Australian market. Similarly, Roca and Wong (forthcoming) reached the same conclusions with regards to Australian superannuation non-SRI funds. Furthermore, this paper found that only the US SRI sector also significantly influences the funds' returns. This implies that the SRI sector in the US is a source of systematic risk for the funds, which can be considered as some sort of an "SRI industry" factor effect.

In terms of the impulse response results, our study reveals that the funds respond to the Australian and US equity markets immediately (positively and then negatively) and quickly (within a period of two weeks). The response to the US SRI sector during the regime of high volatility is completed faster (one week instead of two weeks). Thus, it seems that the responses by Australian superannuation SRI funds are rather efficient (considering that our data was on a weekly basis). Our results with respect to the sensitivity and responses to the US and Australian equity markets, Australian superannuation SRI funds are similar to those reported by Roca and Wong (forthcoming) in relation to Australian superannuation non-SRI funds. Thus, our results provide additional evidence to the claim that performance-wise, SRI funds do not differ significantly from non-SRI funds.

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