An Option Evaluation of being Socially Responsible from a Market Perspective*

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Abstract: This paper attempts to evaluate the value to a corporation of being socially responsible. A responsibility option premium is evaluated using the historical stock prices. The stock market's perspective is assumed to be socially responsible.

Keywords: Real options; uncertainty; socially responsible investment; corporate social responsibility

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1 Introduction

This paper investigates the value of being categorized as socially responsible from the perspective of stock market investors.¹ The value of each firm is measured by its stock price, which means that the value of the firm is the market value or the value of the firm as assessed by stock market participants. This value has been investigated in Tsoutsoura [8], Schnietz and Epstein [7], and framed conceptually in Peloza [5]. The empirical implications are rather vague in the sense that financial market information reflects a lot of firm specific events that result in firm specific noise, which makes it difficult to identify the market impact (if any) on individual stock prices generated by each firm's socially responsible behavior. Papers such as Benson and Humphrey [1] and two papers by Renneboog et al. [6] focus on the performance of socially responsible investment funds. This partially circumvents firm specific effects and a similar approach is used in this paper as well.

In this paper, the noise problem is partially resolved by using a portfolio of stocks instead of observing individual stocks, and by focusing only on the option value ("insurance value" against severe market declines) which is interpreted as the socially responsible factor. So, in a sense the option value considered in this paper is the option premium as assessed by the market, and the option is expected to provide downside protection against a decline in firm value when markets are bearish. More specifically, the SRI fund returns are decomposed into two stochastic factors, the first being the "Market" factor and the second being the "Socially Responsible Investment (SRI)" factor.² If the market return, SRI fund return (observed market return) and the SRI residual factor return (note that this is the stochastic component return that is different from the SRI fund return) are denoted as R_M , R_{Fund} and R_{SRI} respectively, the following equation will hold:

$$R_{Fund} = R_{SRI} + R_M.$$

In the empirical analysis conducted later in the paper, the fund factor R_{Fund} turns out to be positively correlated with the market factor R_M but negatively correlated with the SRI fund return R_{Fund} (Refer to Table 4). This implies that the stochastic factor shared by the SRI fund returns that was identified over the period of financial turmoil, served as insurance for the SRI funds. In section 2.4, this insurance value will be explicitly valued as a put/call option on the SRI factor that is common to all of the SRI funds, and numerically estimated in Table 5.

The SRI factor is the 2nd stochastic factor obtained through a principal component analysis of firms that have been selected by SRI funds. There may be some firms that are "socially responsible" but do not possess this factor (i.e. do not possess a factor that supports stock

¹This is interpreted as passing the screening process of socially responsible fund managers.

²This factor only becomes significant since the financial crash that occurred around September 2008.

prices under financial turmoil). In addition, there may be firms that may possess the stock characteristics that coincide with this SRI factor, but are not selected by SRI funds (i.e. supported by the market but not recognized as socially responsible from SRI fund managers). This paper explores the relation between “firms selected by SRI funds” and “stock price performance” during the financial crash in 2008. Thus, this paper focuses on the stock price behavior of firms that were selected by SRI funds.³

The level of socially responsibility was measured based on the scores assigned by the CSR (Corporate Social Responsibility) database created by Toyo Keizai Shinpo-sha. A simple correlation analysis indicates that there is a relatively high association between the level of cash paid in CSR activities by firms and the firm to be chosen by a so-called SRI (socially responsible investment) fund. This choice by the market (the fact of being included in a SRI fund), can be considered as a signal that the firm is socially responsible from the market’s perspective. In short, the market’s selection of firms that are socially responsible (i.e. firms chosen by SRI funds) have been highly influenced by the amount of cash paid by the firm to CSR activities.

Given the fact that SRI funds are relatively consistent in their choice of firms, it is reasonable to conjecture that the SRI fund price returns posses a specific factor that is strongly related to corporate behavior in a socially responsible sense. This conjecture is investigated by identifying the stochastic factors that comprise SRI fund price returns, and from this analysis, it is observed that the first factor is highly related to the overall market index and the second factor is interpreted as the “socially responsible factor” effect. This second factor was found to possess a different characteristic from all of the 33 TOPIX (Tokyo stock exchange price index) industry indices based on correlation analysis over the period of financial turmoil. This premium for being categorized as a socially responsible firm based on the SRI fund selection criteria is later evaluated with a standard option valuation model. Section 2 provides a detailed description of the data and a summary of the empirical evidence. In section 3, the option premium is estimated and compared over different time periods.

2 Empirical Evidence and Results

2.1 Data Description

This paper utilizes two data sources in conducting its analysis. The first data set is the Toyo Keizei CSR database that scores and documents the various firm activities that are categorized as CSR activities. There are 121 items related to internal activities (in the general section related to the community and the consumer) and this data was used to identify the characteristics of the firms that were chosen to be in SRI funds. Among the various

³This allows us to skip verifying the causality effect of CSR activity on stock price returns.

Table 1: Correlation analysis of SRI fund selection and cash paid for socially responsible activities.

	correlation
Socially Responsible Activity investment amount in year 2004	0.42
Socially Responsible Activity investment amount in year 2005	0.41
Socially Responsible Activity investment amount in year 2006	0.38

characteristics, the analysis was focused on the total cash amount paid to socially responsible activities and whether the firm's stock was chosen by a domestic SRI fund. A simple correlation analysis reveals that the stock selection of SRI funds heavily relied on the cash spent in the SRI activities by the firm. The results are summarized in Table 1. From Table 1, a high correlation between SRI activity investment and selected to be in a SRI fund can be observed, and it is quite natural to conjecture that this investment is a major factor in how market participants evaluate socially responsible activities. There is some literature that supports the observation that corporations' socially responsible investment serve as a kind of insurance premium associated with future firm performance. For example, Peloza [5] says Corporate Social Responsibility (CSR) can potentially serve as insurance to corporate financial performance (CFP) and by mitigating the effects from negative events that could harm the CFP of firms. Particularly, this win-win situation can be observed when the relationship between CFP and CSR are "complimentary" (rather than "conflicting") and the time horizon of managerial perspective is "short-term" (rather than "long-term"). If the investment in SRI activities are recognized to achieve financial gains (i.e. provide a win-win relationship between CFP and CSR) by SRI fund managers, such firms will be selected to be in the SRI fund and are expected to reduce the possibility of the CSR activities to be in "conflict" with CFP benefits. In addition, the high correlation between the investment in SRI activities and the firm being selected to be in a SRI fund is based on a rather short-term period (i.e. only 2–3 years). This suggests an option valuation framework be applied to identify the premium associated with socially responsible behavior by corporations.

The second data source is the Morningstar database from which the monthly return data of all SRI funds were obtained. There are 15 funds available at the moment and a complete list of all of the fund names and management companies is shown in Table 2. In addition to the fund data, I have also used the 33 industrial sectors of the TOPIX market index for comparative purposes. The period is between January 2005 and December 2010. The number of funds used to run the principal component analysis was reduced to 7 SRI funds because of data availability (i.e. only 7 funds had historical data that could be tracked back to January 2005).

Table 2: Socially responsible fund data.

No.	Fund Name	Management Company
F1	Daiwa ShigaBank SRI 3 Asset	Daiwa Asset Management Co., Ltd.
F2	AsahiLife SRI	Asahi Life Asset Management Co., Ltd.
F3	Chuomitsui SRI	Chuo Mitsui Asset Management Co., Ltd.
F4	Daiwa DC SRI	Daiwa Asset Management Co., Ltd.
F5	Daiwa SRI	Daiwa Asset Management Co., Ltd.
F6	MitsubishiUFJ SRI	Mitsubishi UFJ Asset Management Co.,Ltd.
F7	Nippon SRI Open	Okasan Asset Management Co., Ltd.
F8	PineBridge Japan Equity SRI DC	PineBridge Investments Japan Co., Ltd.
F9	Shinkin Fukoku SRI	Shinkin Asset Management Co., Ltd.
F10	Shinkin SRI Japan Equity	Shinkin Asset Management Co., Ltd.
F11	SompoJapan SRI Open	Sompo Japan Nipponkoa Asset Mgmt Co.,Ltd.
F12	STAM DC Good Company SRI	STB Asset Management Co., Ltd.
F13	STAM SRI Japan Equity	STB Asset Management Co., Ltd.
F14	STAM SRI Japan Open	STB Asset Management Co., Ltd.
F15	STAM SRI Japan Open SMA	STB Asset Management Co., Ltd.

2.2 Corporate Behavior and Financial Performance of the SRI funds

The linkage between financial performance and corporate behavior has been discussed in Margarita (2004). Although there are various motivations for corporations to be socially responsible, it would be interesting if it were possible to explicitly extract the value of the signal to be socially responsible using market data. This paper attempts to achieve this by identifying a stochastic component which is common among the SRI funds but different from priced risk factors. When SRI funds are highly correlated with the market, principal component analysis is an effective tool to analyze the fund's characteristics.

One question that remains is that even though it may be possible to statistically identify and estimate the stochastic component that may correspond to socially responsible activity, it may not be obvious why corporations should pay a premium to load on this stochastic factor. There are many potential explanations for this corporate behavior, but this paper will focus on the insurance explanation that has been offered by Pelozo [5]. One may conjecture that there is some kind of insurance value associated with behaving socially responsible that is valuable to its stakeholders given that the stockholders can recognize this value. This means that shareholders would price the socially responsible factor in equity's expected returns. In turn, this implies that the firm's performance may change as a consequence.

Margarita (2004) investigates financial performance at the individual firm level. However, there is one challenge in investigating this phenomenon. The problem lies in the fact that individual stock returns are extremely noisy and this creates statistical problems in identifying the direct impact of being a socially responsible firm. In this paper, I circumvent this issue by focusing on Socially Responsible Investment Funds (SRI funds) in order to reduce the

individual stock noise generated by firm specific events. This allows us to identify an effect over all SRI funds that were observed during the financial crisis from August 2008. This analysis does not only allow us to filter out the individual stock price affects, but also helps us identify the firm characteristics that fund shareholders identify as being valuable. In addition, by using a sample period that includes the financial crisis in 2008 September (the Lehman shock), it is easier to observe the effectiveness of purchasing the put option by investing in socially responsible activities.

2.3 The Model

After decomposing the stochastic components of the returns of SRI funds, the first two components explain the majority of the variability in past stock returns. The first component is clearly the market factor as this factor has a 99% correlation with the TOPIX. The second factor does not possess a high correlation with the overall market but still explains a substantial amount of the return variation, and this is a common factor among the SRI funds.

The model that is applied to the data is principal component analysis. This approach is used when the fund returns are highly correlated and may be represented by several primary underlying unobservable stochastic factors. For an introduction to principal component analysis, one may refer to any basic statistics textbook such as Brooks [2]. Because many of the fund are focusing on socially responsible investments their returns are highly correlated. In such a situation, the returns are very likely to be explained by a handful of dominant stochastic factors when expressed in a system of linear equations. This is one motivation to analyze the funds using principal component analysis. Following the notation of Brooks [2], we have a system of linear equations,

$$\begin{aligned} p_1 &= \alpha_{11}x_1 + \alpha_{12}x_2 + \cdots + \alpha_{1k}x_k, \\ p_2 &= \alpha_{21}x_1 + \alpha_{22}x_2 + \cdots + \alpha_{2k}x_k, \\ &\vdots \\ p_k &= \alpha_{k1}x_1 + \alpha_{k2}x_2 + \cdots + \alpha_{kk}x_k, \end{aligned}$$

where α_{ij} are the coefficients of explanatory variable j for principal component i . There are a total of k principal components $p_1, \dots, p_k$ and $x_1, \dots, x_k$ that correspond to the explanatory variables. In matrix notation, the system of equations may be represented as

$$\mathbf{p} = \mathbf{A}\mathbf{x},$$

where

$$\mathbf{p} = \begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_k \end{bmatrix}, \quad \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix}, \quad \mathbf{A} = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \cdots & \alpha_{1k} \\ \alpha_{21} & \alpha_{22} & \cdots & \alpha_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_{k1} & \alpha_{k2} & \cdots & \alpha_{kk} \end{bmatrix}.$$

Or equivalently, in sigma notation, it may be expressed as

$$p_i = \sum_{j=1}^k \alpha_{ij} x_j, \quad \forall i = 1, \dots, k.$$

The coefficients α_{ij} are restricted in the sense that the square of the row elements must sum up to unity. If the number of observations used to estimate the coefficients is T , then each explanatory variable will have T observations that can be represented as the following:

$$\mathbf{X} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1T} \\ x_{21} & x_{22} & \cdots & x_{2T} \\ \vdots & \vdots & \ddots & \vdots \\ x_{k1} & x_{k2} & \cdots & x_{kT} \end{bmatrix}.$$

Here, each row corresponds to the array of observations for an explanatory variable. In particular, these variables correspond to the returns of the SRI funds. There are k funds in total, where the fund returns are calculated over a period with T observations.⁴ The principal components may be interpreted as the eigenvalues of the design matrix $\mathbf{X}'\mathbf{X}$. The number of eigenvalues will be equal to the rank of the design matrix $\text{rank}(\mathbf{X}'\mathbf{X})$, which is k because the set of linear equations is not degenerate. Denoting the eigenvalues as λ_i for $i = 1, \dots, k$, the proportion of variance that is explained by this component can be expressed as the following:

$$\varphi_i = \frac{\lambda_i}{\sum_{j=1}^k \lambda_j}, \quad \forall i = 1, \dots, k,$$

where φ_i is the proportion that is explained by principal component i .

The two models summarized in this section will be applied to the data set described in the following section.

The put and call option values are calculated in two ways. The first method uses the Black-Scholes-Merton option pricing model:

$$p = Ke^{-rT}N(-d_2) - S_0N(-d_1),$$

$$c = S_0N(d_1) - Ke^{-rT}N(d_2),$$

⁴The analysis was conducted with monthly returns (not annualized) for 7 funds. There were 72 observations in total (starting from 2005 Jan. to 2010 Dec.)

where

$$d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}},$$

$$d_2 = d_1 - \sigma\sqrt{T}.$$

Here, the premium of a put option (p)/call option (c) is the premium associated with socially responsible behavior; the underlying asset (S_0) is the estimated return of a stochastic factor that is interpreted as the SRI factor; the exercise price of the call option (K) is the current value of the underlying asset; the maturity of the option (T) is the remaining period for the firm possessing the socially responsible option; the interest rate (r) set equal to the risk free rate. The instantaneous volatility of the underlying asset value (σ) is obtained by numerically calculating the historical returns of the stochastic factor. Because of there are reservations on the assumptions of the Black–Scholes Model (such as tradability and normality), a robustness check is conducted by calculating the 3 month option premiums using the empirical distribution of the second principal component. The empirical distribution is estimated from the histogram of the return distribution that is estimated using a cubic spline that is later smoothed by taking the moving average (with a window of 10 points) of the distribution function. The PDF of the empirical distribution is depicted in Figure 1, and the option premiums were calculated based on this distribution function using Monte Carlo simulation.

In our framework, the underlying asset to be considered is the second stochastic factor that is identified from the principal component analysis. Due to its characteristics, this second factor is called the SRI fund factor.⁵ The option approach best fits our analysis because of its easy interpretation; and it values behaving in a socially responsible way. Explanation of the Black-Scholes-Merton equation may be found in any basic derivative textbook such as Hull [3]. The Black-Scholes option framework applies to European options. The validity of considering a European option as opposed to an American option lies in the potential application where the SRI factor may be used to rebalance a portfolio position held for a relatively long term horizon. In such an application, the portfolio may be rebalanced on a quarterly basis. This provides a justification on why the maturity of the option is to be held for 3 months (or one quarter). Because of the potential difficulty in trading the underlying asset (i.e. principal component), the option values are calculated based on the empirical distribution as well. However, the primary purpose of the option analysis is more to show that there exists a significant value (or premium) attached to the second stochastic factor.

⁵Although this factor is not directly traded in the market, it may be traded by constructing a portfolio of the 7 funds used in the principal component analysis. A detailed discussion on how the second factor can be constructed is given in Appendix A.

Figure 1: Estimated probability distribution of the second component.

2.4 Principal Component Analysis and Option Valuation

Principal component analysis is conducted for all of the SRI funds that existed over the sample period starting from January 2005 and ending in December 2010 (This period includes the financial crisis of September 2008). Although there are 15 SRI funds available today, only 7 were used in the analysis due to data availability. After decomposing the stochastic components of the returns of the SRI funds as described in the previous section, there are at least two distinctive components whose eigenvalues, the proportion of variability and the cumulative proportion of variability that are interesting. These are shown in Table 3. Table 3 Panel A shows the results obtained when the analysis is conducted on the Fund Returns. The first component (PC1) is the most dominant factor that explains more than 90% of the fund behavior. The second factor (PC2) explains about 5% of the total behavior and is the most likely candidate to be the socially responsible factor. Although the eigenvalue given in Table 3 Panel A is less than 1 for the second factor, the analysis in Table 3 Panel B shows the analysis after removing the market factor (i.e. TOPIX), it is clear that there is a significant reduction in the variance contribution after the first factor (this corresponds to the second factor in Panel A). Table 3 Panel C provides the loadings of the two stochastic factors of interest. According to Jackson [4], there is a method that chooses the number of factors where the total variance comprise 95% of the total variation with some reservations. In

Table 3: Principal component analysis.

Panel A: Eigenvalue, proportion and cumulative proportion of variance for fund returns.

Comp. No.	Eigenvalue	Proportion	Cumulative
PC1	6.36	0.91	0.91
PC2	0.36	0.05	0.96
PC3	0.12	0.02	0.98

Panel B: Eigenvalue, proportion and cumulative proportion of variance for excess returns.

Comp. No.	Eigenvalue	Proportion	Cumulative
PC1	2.11	0.30	0.30
PC2	1.22	0.17	0.48
PC3	1.06	0.15	0.63

Panel C: Factor loadings of the principal components.

	Fund Number/Name	PC1	PC2
2	F2/AsahiLife SRI	0.38	-0.08
4	F4/Daiwa DC SRI	0.39	-0.18
5	F5/Daiwa SRI	0.38	-0.22
6	F6/MitsubishiUFJ SRI	0.38	-0.11
9	F9/Shinkin Fukoku SRI	0.39	-0.16
12	F12/STAM DC Good Company SRI	0.39	-0.06
14	F14/STAM SRI Japan Open	0.33	0.94

Panel D: Bartlett's test results.

Factors	1-7	2-7	3-7	4-7	5-7	6-7
Probability	0	0	0	0	0.3594	0.765

addition to satisfying this criterion, the number of components to be included in the principal component analysis is 4 according to the Bartlett's test. The p-value for the test are presented in Table 3 panel D and this validates the inclusion of second component. In order to tease out how each stochastic component relates to the overall stock market, a correlation analysis is shown in Tables 4 and 5.

In Table 4, the correlation with AsahiLife SRI (F2), Daiwa DC SRI (F4), Daiwa SRI (F5), MitsubishiUFJ SRI (F6), Shinkin Fukoku SRI (F9), STAM DC Good Company SRI (F12) and STAM SRI Japan Open (F14) and the two stochastic components (PC1, PC2) are given. It can clearly be observed that the first component is positively correlated with all of the funds used in the analysis at a high level. Because the first component is highly correlated with the TOPIX index (near to 99%), it is rather natural to assume that this component corresponds to the market factor. The second component⁶ is small in magnitude

⁶It should be noted that the second factor does not have a significant size (less than 1) in its eigenvalue when compared to the first component, but that this component becomes dominant when a principal component analysis is conducted for excess returns (over the TOPIX index). Thus, there is a good reason to investigate

Table 4: Factor loadings of the two principal components.

	Fund Number/Name	PC1	PC2
2	F2/AsahiLife SRI	0.95	-0.05
4	F4/Daiwa DC SRI	0.99	-0.11
5	F5/Daiwa SRI	0.96	-0.13
6	F6/MitsubishiUFJ SRI	0.96	-0.06
9	F9/Shinkin Fukoku SRI	0.99	-0.10
12	F12/STAM DC Good Company SRI	0.99	-0.04
14	F14/STAM SRI Japan Open	0.83	0.56

when compared to the first component (it still explains about 5% of the variation), but interesting weakly negatively correlated with the exception of F14. This indicates that this factor is unrelated to the market, but is a factor related to the firms that constitute the SRI funds. This allows us to conjecture that the second stochastic component is related to some kind of factor that is highly associated with firms that have been selected by SRI funds. In addition, the uncorrelated behavior with the market index (TOPIX) will serve as insurance to adverse movements in the TOPIX index. This is later evaluated in an option framework.

The fund returns may be decomposed into two factors, one related to the market factor and another defined as the SRI factor. In Table 4, the correlation between the fund returns and the two factors are given and the second factor exhibits weak negative correlation. In Table 5, the correlation between the market returns (not fund returns) and the two factors are given where the first factor exhibits strong positive correlation and the second factor exhibits weak negative correlation.

In Table 5, I examine how the two stochastic factors are related to specific industries by observing the correlation between the two stochastic components and a proxy for market returns (TOPIX). The analysis was conducted for all of the TOPIX industry sector returns (33 sectors in total) and the TOPIX index itself. This analysis confirms that the first stochastic component PC1 indeed corresponds to the overall market because the correlation with the row “Topix PR JPY” is 0.99 (shown in bold). This means that PC1 mimics the behavior of the TOPIX. By combining this argument with the fact that PC1 explains a most of the SRI Fund return behavior, it becomes quite clear that PC1 may be interpreted as the market factor. One more interesting observation is that the second stochastic component PC2 is not highly correlated with any of the TOPIX subindices. This implies that the SRI funds are not following the behavior of a particular sub-sector of the TOPIX, and reaffirms the fact that this stochastic factor is unique, not only for the overall stock market behavior, but also for each industry.

this factor.

Table 5: Correlation with principal components and the TOPIX 33 industrial sectors.

	PC1	PC2
Topix Air Transport PR JPY	0.14	-0.28
Topix Banks PR JPY	0.79	-0.01
Topix Chemicals PR JPY	0.95	-0.07
Topix Communication PR JPY	0.69	-0.14
Topix Construction PR JPY	0.83	-0.06
Topix Electronic Appliances PR JPY	0.92	0.02
Topix Electronic Power&Gas PR JPY	0.12	-0.04
Topix Financing Business PR JPY	0.74	-0.05
Topix Fishery Agricul&Forest PR JPY	0.62	0.02
Topix Foods PR JPY	0.73	-0.09
Topix Glass&Ceramics PR JPY	0.90	0.01
Topix Insurance PR JPY	0.76	0.03
Topix Iron&Steel PR JPY	0.84	0.00
Topix Land Transport PR JPY	0.64	-0.22
Topix Machinery PR JPY	0.94	-0.04
Topix Marine Transport PR JPY	0.76	-0.06
Topix Metal Products PR JPY	0.84	-0.07
Topix Mining PR JPY	0.65	-0.17
Topix NonFerrous Metals PR JPY	0.90	-0.08
Topix Oil&Coal Products PR JPY	0.73	-0.02
Topix Other Products PR JPY	0.75	-0.02
Topix Pharmaceutical PR JPY	0.70	0.05
Topix PR JPY	0.99	-0.07
Topix Precision Instruments PR JPY	0.86	0.06
Topix Pulp&Paper PR JPY	0.54	-0.19
Topix Real Estate PR JPY	0.78	-0.23
Topix Retail Trade PR JPY	0.80	-0.22
Topix Rubber Products PR JPY	0.63	0.06
Topix Securities PR JPY	0.82	-0.08
Topix Services PR JPY	0.83	-0.18
Topix Textiles&Apparels PR JPY	0.83	-0.20
Topix Transport Equipment PR JPY	0.81	-0.00
Topix Warehousing PR JPY	0.68	-0.28
Topix Wholesale Trade PR JPY	0.87	-0.11

Table 6: At-the-money, in-the-money and out-of-the-money option values the socially responsible stochastic component (risk free rate = 0.01%, PC2 volatility = 16.9% (without outlier), maturity = 3 months).

Maturity 1 month			Maturity 3 month		
Moneyiness	Call option	Put option	Moneyiness	Call option	Put option
0.90	0.115	0.017	0.90	0.142	0.046
0.95	0.079	0.031	0.95	0.113	0.066
1.00	0.051	0.051	1.00	0.086	0.089
1.05	0.029	0.079	1.05	0.065	0.118
1.10	0.015	0.117	1.10	0.047	0.153

In short, among the two stochastic components (PC1 and PC2) SRI fund returns, the first component explains a majority of the variability in the past stock returns, and it is very likely to be the market factor. The second factor does not possess a high correlation with the overall market but still explains a considerable amount (5%) of the returns, and this is a common factor across all SRI funds. There is little doubt that this factor is an SRI fund factor. The focus of this paper is not to examine whether this behavior was caused by socially responsible activities of the firms in the SRI funds, but rather the stock behavior of firms that were able to “convince” the SRI funds that they are socially responsible (i.e. successfully signaled themselves as socially responsible firms to the “market”). In this context, the second stochastic factor will be called the “socially responsible” factor in this paper henceforth. The option values of this second stochastic factor are calculated in the next section using the empirical distribution and Black-Scholes formula.

Table 6 estimates the put option values for the second stochastic component (PC2) that it is interpreted as the socially responsible corporate behavior factor (i.e. the underlying asset of the option). The results presented in Table 6 are normalized by the time 0 price of the underlying asset (S_0). This means that the initial price is set to 1 and the subsequent prices are derived by multiplying cumulative returns of the underlying asset. The volatility is the return volatility where all numbers are based on monthly intervals (not annualized). This makes the maturity of the options to be 3 (months).

The options are calculated for the period from January 2005 to December 2007 (the pre-financial crisis period). The maturity of the option is 3 months, and the details of the formula are given in the previous section. The risk free rate is the average interest rate provided by the Bank of Japan website over the lifetime of each option. Yet this value was 0.1% and had virtually no impact on our analysis. The volatility is calculated based on historical volatility, but the outlier observation (December 2005) was removed from the analysis. The rows represent the moneyiness of the options which are 10% out-of-the-money, 5% out-of-the-money, at-the-money, 5% in-the-money and 10% in-the-money respectively. It is interesting

that the magnitude of the options do not differ significantly.

In the case of a financial crisis where the market index falls together with the SRI fund returns, it would be reasonable to use out-of-the money put/call options to hedge the extreme movements in the return (because the fund/market returns are negatively correlated with the second stochastic component).⁷ For example, if the SRI fund returns and the second stochastic factor (PC2) move in opposite directions, the use of out-of-the money call options will provide profits when the SRI fund returns decreases because PC2 generally increases due to the negative correlation. Because the SRI fund returns and the second stochastic factor are not perfectly correlated, there are cases where the SRI fund returns and the second stochastic factor move in the same direction, but on average, they will move in opposite directions. The hedge effect of the options are illustrated in Appendix B for a portfolio consisted of 50% TOPIX and 50% Call option of the second principal component whose graph is shown in Figure 2. Figure 3 shows the movements of the first two principal components.

3 Conclusion and Implications

This paper has analyzed socially responsible firm behavior and its potential option value, or in other words, its insurance value during the financial crisis in Japan. The level of each firm's social responsibility is measured in terms of the market assessment which has been approximated by the SRI fund stock selection policy. The portfolio approach (i.e. using the SRI fund data instead of individual stock data) significantly reduced the firm specific effect and enabled the extraction of a stochastic component that appears to be the "socially responsible" factor. The put/call option value of this stochastic component is calculated in order to evaluate the premium of being selected by a SRI fund, or equivalently labeled to be socially responsible from the market's perspective. The option value becomes significant and provides preliminary evidence that the socially responsible investment may have "paid-off" during the financial crisis that occurred in September 2008.

A Construction of the Second Principal Component

The following table shows the returns of the first two components and the fund returns (centered by the mean and normalized by the standard deviation).

⁷Because the actual distribution is highly skewed during a financial crisis, it is hard to articulate on what the precise impact of purchasing such options would have been, but it is rather clear that there would be a significant impact.

Figure 2: Returns of TOPIX and portfolio (Call option on PC2 + TOPIX).

	PC1	PC2	F2 RET	F4 RET	F5 RET
2005M01	-0.167	0.038	-0.006	-0.085	-0.0378
2005M02	1.273	0.064	0.316	0.553	0.545
	F6 RET	F9 RET	F12 RET	F14 RET	
2005M01	-0.063	-0.112	-0.111	-0.018	
2005M02	0.528	0.478	0.456	0.496	

By defining the fund return vector (1×7) for January 2005 as $F(2005M01)$ and the factor loadings (eigenvector) of the second component $E2$, the return of the second component 0.038 can be reconstructed by taking the inner product of the two vectors. Because the funds are tradable, the principal components can be reconstructing by forming an appropriate portfolio of the SRI funds.

B Hedge Effect

Figure 2 illustrates the hedge effect of a portfolio consisted of 50% TOPIX and 50% Call option of the second principal component. There is significant reduction in the drop of the return in late 2008.

Figure 3 depicts the movement of the first two principal components.

Figure 3: Returns of the first two principal components.

References

- [1] Benson, K.L. and Humphrey, J.E. (2008). Socially responsible investment funds: Investor reaction to current and past returns. *Journal of Banking and Finance*, **32**, 1850–1859.
- [2] Brooks, C. (2002). *Introductory Econometrics for Finance*. Cambridge University Press, Cambridge.
- [3] Hull, J. (2006). *Options, Futures and Other Derivatives*, 6th ed. Prentice Hall, New Jersey.
- [4] Jackson, D.A. (1993). Stopping rules in principal components analysis: A comparison of heuristical and statistical approaches. *Ecology*, **74**, 2204–2214.
- [5] Peloza, J. (2006). Using corporate social responsibility as insurance for financial performance. *California Management Review*, **48**, 52–72.
- [6] Renneboog, L., Horst, J.T. and Zhang, C. (2008). Socially responsible investments: Institutional aspects, performance, and investor behavior. *Journal of Banking and Finance*, **32**, 1723–1742.
- [7] Schnietz, K.E. and Epstein, M.J. (2005). Exploring the financial value of a reputation for corporate social responsibility during a crisis. *Corporate Reputation Review*, **7**, 327–345.
- [8] Tsoutsoura, M. (2004). Corporate social responsibility and financial performance. Working Paper, Center for Responsible Business, UC Berkeley.