The pricing of inflation and exchange rate risks on the South African socially responsible investment index: An application of the APT model

Owing to the systematic forces inherently present in all equity markets, investors require a premium for bearing any portion of risk when investing in stock markets. As such, the pricing of certain macroeconomic variables and the behaviour of asset returns are major concerns for investors and financial practitioners alike. The exchange rate and inflation rate are amongst the risk factors that affect different indices of the South African stock market. One of the stock market indices that can be affected by these risks is the growing socially responsible investment (SRI). This research made use of a three-factor arbitrage pricing theory (APT) model to investigate the exposure of the South African SRI index to exchange rate and inflation rate risks. The sample period consists of 104 monthly observations from January 2006 to August 2014 and the 38 companies that have been part of the SRI index during this period. Findings of the study showed that the results of conditional and unconditional asset pricing models differed, and the conditional model produced reliable results. The inflation and market risks were found to be priced in the SRI index, but there was no evidence supporting the pricing of the exchange rate risk in this index. The study therefore concluded that the exchange rate risk is diversifiable in the SRI index, whilst inflation risk is not.

Introduction

Stock return is normally exposed to different risk factors related to systematic and unsystematic forces. Owing to the systematic forces inherently present in all equity markets, investors require a premium for bearing a portion of risk when investing in stock markets. As such, the pricing of certain macroeconomic factors and the behaviour of asset returns are major concerns for investors and financial practitioners alike. An important part in investing is determining whether a risk premium accompanying a risk factor is statistically significant. With the formation of the socially responsible investment (SRI) index in 2004, an array of opportunities has been created for investors interested in socially responsible investing. Socially responsible investing is defined as an investment strategy that takes into account societal and/or environmental benefits when making financial investment decisions (JSE 2004). Socially conscious investors, like many other investors, are primarily concerned with systematic or non-diversifiable risks linked to investing in the SRI index.

The SRI consists of companies that aim to attain a high environmental, social and governance (ESG) rating by following investment strategies such as screening, shareholder activism and cause-based investing (JSE 2004). The above-mentioned investment strategies create a substantial sector and economic bias (Kutz & DiBartolomeo 1996). The SRI is a sub-index of the Johannesburg Stock Exchange (JSE), and it has been associated with certain macroeconomic factors (Muzindutsi & Sekhampu 2013). However, it is not clear which macroeconomic variables are priced in the SRI index. Other key macroeconomic factors that tend to affect several stock market indices include the exchange rate and inflation risk factors (Jorion 1991). Hence, this warrants further investigation as to whether socially responsible investors require a risk premium on being exposed to exchange rate and inflation risk factors.

In assessing the pricing risk factors in the stock market index, the arbitrage pricing theory (APT) is utilised in the study. The APT model is a multifactor model that relays the expected returns associated with each risk factor and describes the variations on a cross-sectional basis (Szczygielski 2013). APT, as a model, has greater explanatory powers than previous pricing models such as the Capital Asset Pricing Model (CAPM) because it gives allowance to more than one risk factor and allows the construction of factors that best fit the data (Fama & MacBeth 1973). The APT asserts that stock returns are a linear function of multiple macroeconomic factors (Chawana 2011). In the APT model, the risk premium is defined as the slope coefficient in the linear relation between
Inflation rate as a risk factor in the stock market index

The central motivation to selecting inflation rate risk is the Fisher effect, which links nominal stock prices to corresponding changes to inflation, as well as highlights the positive statistical relationship between these two variables (Al-Khazali & Pyun 2004). The Fisher effect states that shares are in essence a hedge against inflation risk, which is because of the fact that share returns are said to have a positive return that compensates for the loss in purchasing power caused by inflation rate risk (Correa & Wormald 1988). Stocks are therefore believed to have inflation hedge characteristics (Elton, Gruber & Rentzler 1983). For example, Arjoon et al. (2012) maintained that because of the long-run relationship between inflation rate risk and real stock prices, investing in real stocks could in essence provide a hedge against inflation rate risk. However, the type of inflation rate to be used in the APT model is still controversial. Correa and Wormald (1988) supported the notion that APT as a model only took into consideration inflation rate as a risk factor only if there was an unexpected change in inflation. However, Hamao (1988) contended that an expected inflation rate rather than unexpected inflation rate has a more consistent explanatory power with regard to share returns. The fundamental theories of risk stipulates that unexpected changes in macroeconomic factor are legitimate risk factors (Berry et al. 1988) as any expected changes could not be considered as a risk because it can be hedged or avoided by investors. The study therefore makes use of unexpected changes to inflation.

On an empirical standpoint, Azeez and Yonezawa (2006) examined the pricing of inflation rate risk within the Japanese stock market using the APT model and found that inflation risk was adequately priced. Reese (1993) stated that the APT identified unexpected changes in the macroeconomic factors as risk factor loadings that should be tested. However, an empirical investigation of the APT model by Hamao (1988) in the Asian stock market indicated that fluctuations in the expected inflation rate along with unexpected fluctuations in the risk premium significantly affected Asian stock returns. In the context of South African SRI index, Muzindutsi and Sekhampu (2013) found that the short-run relationship between inflation and the SRI index was not significant, whilst it became significant in the long run. This suggests that there may be a link between inflation and the SRI index returns but it is not clear whether this factor is priced in the South African socially responsible investors require risk premium for being exposed to inflation rate risk.

Exchange rate risk as a risk factor in the stock market index

Exchange rate exposure amongst firms varies from firm to firm in relation to how it affects the value of the firm. In essence, because of increasing globalisation, not only

Literature review

The application of the APT model in analysing the pricing of macroeconomic factors in the stock market index should make use of pre-specified risk factors, to attain a more meaningful analysis (Berry, Burmeister & McElroy 1988; Chen, Roll & Ross 1986; Conway & Reinganum 1988). For the output of the APT to have a more meaningful economic interpretation, pre-specified macroeconomic factors should be regarded as legitimate by meeting a number of characteristics (Azeez & Yonezawa 2006; Berry et al. 1988). Firstly, the factor must be entirely unpredictable to the market; secondly, the factor must have an inescapable influence on stock market returns; and lastly, the factor must influence expected stock market returns or have a non-zero impact on stocks market prices (Berry et al. 1988). Thus, there must be a definite change in stock market prices because of the unexpected change in the pre-specified risk factor. This suggests that stock market prices are predominantly influenced by economic news linked to a wide array of unanticipated events that have an inescapable effect on stock market prices. Stock market price behaviours are therefore linked to observed macroeconomic factors driven by unanticipated macroeconomic events (Azeez & Yonezawa 2006). The effect of such macroeconomic factors may differ from one stock market index to another and some factors may be priced in the stock market index, whilst other may not. In the context of the study, inflation and exchange rates are tested to indicate if they are priced or not within the SRI.

the expected returns and their covariance (Huberman & Wang 2005). APT has been used to establish how various macroeconomic factors are priced in the whole market index, such as JSE All Share Index or within a specific index, such as the industry-based index. However, in a screened index, such as SRI index, the pricing of certain factors may differ from that of conventional indices because of the screening process that companies are required to undergo every year (Kutz & DiBartolomeo 1999).

The South African SRI index was launched by the JSE in May 2004, and it was the first of its kind in an emerging market. The index has developed in recent years as a vigorous and rapidly growing segment of the JSE (2014). The JSE SRI index was created because of the immense interest shown by investors and money managers who were looking for greener investment opportunities (Herringer, Firer & Viviers 2009), and it has become an essential investment style within the South African investment community (Brzeszczyński & McIntosh 2014). Companies in the SRI index go through a screening process to determine whether they comply with the social responsible requirements, implying that the SRI index tends to have different characteristics that might predispose different asset return behaviour (Nguyen 2010). Thus, a further analysis of the application of APT in determining whether certain macroeconomic factors are priced in the SRI index may shed more light that can enhance their investment decisions. Thus, the study makes use of the APT to assess the pricing of selected pre-specified macroeconomic factors, namely inflation rate risk and exchange rate risk, in the SRI index.
firms that deal with the import and export of goods and services but also firms that operate solely within a country are affected by adverse exchange rate movements (Adler & Dumas 1984; Muzindutsi & Nyimbanira 2012), which thus makes exchange rate a major macroeconomic concern for all investors, as exchange rate fluctuations impact not only the cash flow of a company’s operations but also variations in the discount rate utilised to value these cash flows (Barr, Kantor & Holdsworth 2007). Thus, investors are primarily concerned with unanticipated fluctuations to the exchange rate as this unexpectedly affects share prices. The pricing of exchange rate risk within the emerging markets is both statistically and theoretically proven to be significant (Abdalla & Murinde 1997). Because of the fact that the SRI is a sub-sector of the JSE, it stands to reason that it is also affected by the exchange rate risk. Muzindutsi and Sekhampu (2013) found that a long-run relationship existed between the JSE SRI index and real exchange rate risk, but it did not suggest that real exchange rate risk is priced in the SRI index. Although some studies (Jorion & Giovannini 1989; Muzindutsi & Nyimbanira 2012; Reese 1993) found exchange rate risk to be priced in the stock market, others found that the exchange rate was not statistically and economically significant in explaining the expected stock market returns (Dominguez & Tesar 2001; Hamao 1988; Jorion 1991; Khoo 1994). This shows that the pricing of the exchange rate in the stock market index may vary from stock market to stock market or sector/index to sector/index. Thus, it is important to test whether exchange rate risk is priced within a screened index such as the JSE SRI index.

Methodology

Data

The data include actively traded stocks from the JSE, which have been present in the JSE SRI index for the 2006–2014 period. This period was chosen simply to ensure that the selected companies have maintained high performance in SRI activities for the past 9 years. The sample size consists of 38 companies with 104 monthly observations for each company. Data on each individual company were obtained from the McGregor Bureau of Financial Analysis (FBA) database, and the inflation rate and real effective exchange rate were obtained from South African Reserve Bank. Unexpected changes in both inflation rate and real effective exchange rate were used as Berry et al. (1988) suggested that the factors chosen for APT model must constitute unexpected movements at the beginning of the selected period and should be uncorrelated over time.

Model specifications

The study used a multifactor APT model to test the pricing of the inflation rate and the exchange rate in the JSE SRI index. A factor in the APT is priced when there is a risk premium aligned with such risk factor of the asset (Jecheche 2012). The risk premium can be identified through the use of a two-pass regression model, which is extensively used in the literature (Chen 1983; Roll & Ross 1980). This involves the use of the first-pass regression to estimate risk factors (betas) and the second-pass regression, which uses these betas to estimate risk premium attached to each risk factor. The first-pass regression, which was used to estimate the market, inflation and exchange rate betas for each company in the SRI index, is as follows:

\[
R_i = \beta_0 + \beta_m R_m + \beta_{INFL} INFL_t + \beta_{ER} ER_t + \epsilon_i
\]

where \( R_i \) is the return for a company \( i \) at time \( t \), \( R_m \) is the rate of return on the market at time \( t \), \( INFL \), and \( ER \) are unexpected movement in inflation and exchange rate at time \( t \), respectively, \( \beta_m \) is the risk-free rate, \( \beta_{INFL} \) and \( \beta_{ER} \) are risk premium attached to each risk factor. The second-pass regression, which was used to estimate the risk premium of betas from Equation 1, is as follows:

\[
RP_i = \lambda_i + \lambda_{INFL} \beta_{INFL} + \lambda_{ER} \beta_{ER} + \epsilon_i
\]

where \( RP_i \) is the risk premium for a company \( i \) (\( R_i - R_m \)); \( \lambda_i \) is the intercept, which can also be the risk-free rate; \( \lambda_{INFL} \) is the market risk premium; \( \lambda_{ER} \) is the inflation risk premium; \( \lambda_{INFL} \) is the inflation risk premium; \( \lambda_{ER} \) is the exchange rate risk premium; \( \beta_{INFL} \) and \( \beta_{ER} \) are inflation risk and exchange risk, respectively, and \( \epsilon_i \) is the error term. The second-pass regression was conducted to ensure that the sign of the coefficients is as expected (p-values < 0.5), and this indicates that there is no correlation between the independent variables, which suggests that there is no presence of multicollinearity. The next was to use the first-pass regression (Equation 1) to estimate betas (coefficients) for each factor. These betas were

![Table 1: Pearson correlation between independent variables.](http://www.icbmd.org/diagrams/table1.png)
then used as inputs for the second-pass regression and are not reported in this paper.

Using the betas (coefficients) from the first-pass regression, the risk premium of each factor was estimated by making use of the second-pass regression (Equation 2). The estimation of risk premium followed both conditional and unconditional APT models. Firstly, unconditional APT that used endogenous risk-free rate (intercept) was estimated, and its results were compared with those of conditional APT with exogenous risk-free rate or predetermined intercept to identify a better model. Results of both models are presented in Tables 2–3.

Table 2 shows the estimates of the unconditional model (with endogenous intercept/risk-free rate). The coefficient for the market risk premium is positive but is not statistically significant, even at the 10% level of significance, which means that there is no unconditional market premium in the SRI index. The coefficient for inflation risk premium is statically significant at the 5% level of significance (p-value < 0.5), meaning that the unconditional inflation risk premium is different from 0. Thus, inflation risk is associated with an unconditional risk premium of 2.4593% per month, but it has a negative sign, which is unexpected. The exchange rate risk premium is not statistically significant and has a negative sign, which is unexpected. The R² of 0.180243, which is statistically significant at the 10% level of significance (probability of F-statistic < 0.1), means that all independent variables jointly explain about 18.02% of the returns of the SRI companies. The Durbin-Watson stat of 1.9359 is close to 2, suggesting that there is no first-order autocorrelation amongst the residuals. Further residuals diagnostic tests (Breusch-Godfrey Serial Correlation LM tests and Breusch-Pagan-Godfrey Heteroskedasticity) also confirm that there was no presence of serial correlation and heteroscedasticity (p-values > 0.1) in the results of the unconditional APT model.

The results of conditional second-pass regression, as can be seen in Table 3, show that market risk premium and inflation risk premium are statistically significant at the 1% level of significance (p-values < 0.01) and have a positive sign, which is correct/expected. The monthly risk premia for market and inflation are 0.812% and 1.934, respectively. Similar to the results of the unconditional model, the exchange rate risk premium is not statistically significant (p-values > 0.1) in the conditional model, but it has the expected positive. Breusch-Godfrey Serial Correlation LM Test and Breusch-Pagan-Godfrey Heteroskedasticity Test show that there is no autocorrelation nor is there heteroscedasticity (p-values > 0.1) in the conditional model. Comparing the two models, the conditional model produced expected signs for all coefficients and has higher R² and adjusted R², implying that it produced better results than unconditional model. Thus, the risk premium estimated by the conditional model is discussed.

**Discussion**

The application of the three-factor APT model showed that socially responsible investors seem to attach risk premium to market and inflation factors, whilst there was no evidence of exchange rate risk premium. The selection of the model showed that the conditional APT outperformed the unconditional one, implying that the methodology used to determine risk premium tends to affect the results. The finding concurs with other studies (Carrieri & Majerbi 2006; Doukas, Hall & Lang 1999; Dumas & Solnik 1995) that insist that the results of conditional and unconditional asset pricing models tend to differ. Results of the study showed that returns in the SRI index seem to be associated with conditional risk premium, and this is consistent with the study of Jorion (1985), which states that macroeconomic factors in the APT models are characterised by conditional risk premium. Besides the market risk premium, socially responsible investor seems to attach a premium to exposure of the inflation risk, which implies that inflation risk is priced in the SRI index. The finding is in line with other studies (Al-Khazali & Pyun 2004; Azeez & Yasuhiro 2006; Hamao 1988), which found that inflation rate risk was adequately priced in the different stock market index. Thus, inflation risk is not a diversifiable risk in the SRI index.

Although the exchange has been found to be a significant risk factor in the South African stock market (Barr et al. 2007; Muzindutsi & Niyimbana 2012; Reese 1993), there appears to be no premium attached to the exchange rate risk in the SRI index. The exchange rate risk is therefore not priced in this index, and this is also contrary to other findings (Carrieri & Majerbi 2006; Doukas et al. 1999; Muller & Verschoor 2006) from other emerging stock markets. However, the finding is in line with studies (Dominguez & Tesar 2001; Hamao 1988; Jorion 1991; Khoo 1994) that found that there was no premium attached to the exchange rate risk. The plausible explanation behind this finding is that exchange rate exposure varies between firms of the SRI index, as some firms in the index tend to suffer from depreciation/appreciation of the rand, whilst other firms benefit from depreciation/appreciation of the rand. Consequently, the exchange rate risk seems to be diversified in the SRI index.

**TABLE 2: Second-pass unconditional regression results.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>SE</th>
<th>t-Stat</th>
<th>P-value</th>
<th>Regression statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>λ_m</td>
<td>0.00882</td>
<td>0.00343</td>
<td>2.57095</td>
<td>0.0147</td>
<td>R² = 0.180243</td>
</tr>
<tr>
<td>λ_w</td>
<td>0.00017</td>
<td>0.00343</td>
<td>0.05008</td>
<td>0.9603</td>
<td>F-statistic = 2.49189</td>
</tr>
<tr>
<td>λ_i</td>
<td>-0.02459</td>
<td>0.01015</td>
<td>-2.4231</td>
<td>0.0209</td>
<td>Prob (F-statistic) = 0.0767</td>
</tr>
<tr>
<td>λ_u</td>
<td>-0.00041</td>
<td>0.00408</td>
<td>-1.0049</td>
<td>0.9202</td>
<td>Durbin-Watson stat = 1.9359</td>
</tr>
</tbody>
</table>

Unconditional model: RP = λ_m * t_E + λ_w * t_w + λ_i * t_i + u_i
Breusch-Godfrey Serial Correlation LM Test: F-statistic = 0.728852; Prob. = 0.4903.
Breusch-Pagan-Godfrey Heteroskedasticity Test: F-statistic = 1.581562; Prob. = 0.2118.

**TABLE 3: Second-pass conditional regression results.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>SE</th>
<th>t-Stat</th>
<th>P-value</th>
<th>Regression statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>λ_m</td>
<td>0.00812</td>
<td>0.00161</td>
<td>5.043131</td>
<td>0.0000</td>
<td>R² = 0.19562</td>
</tr>
<tr>
<td>λ_w</td>
<td>0.01934</td>
<td>0.02775</td>
<td>4.30051</td>
<td>0.0001</td>
<td>Durbin-Watson stat = 2.1242</td>
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<tr>
<td>λ_i</td>
<td>0.00597</td>
<td>0.00372</td>
<td>1.62081</td>
<td>0.1180</td>
<td></td>
</tr>
</tbody>
</table>

Conditional model: RP = λ_m * t_E + λ_w * t_w + λ_i * t_i + u (with exogenous risk-free rate).
Breusch-Godfrey Serial Correlation LM Test: F-statistic = 0.27478; Prob. = 0.7614.
Breusch-Pagan-Godfrey Heteroskedasticity Test: F-statistic = 1.4449; Prob. = 0.2469.
Conclusion
The study examined the APT and its efficiency and adequacy in pricing stock market returns within the South African SRI index. Given that the theory itself does not provide a set of macroeconomic variables, the study used a set of pre-specified macroeconomic variables, namely inflation rate risk and exchange rate risk, which substantiates this selection with economic theory. The selection of the model showed that the results of conditional and unconditional asset pricing models differed, and the conditional model produced reliable results. The South African SRI index is exposed to market and inflation risks, but there was no evidence supporting the exchange rate exposure in the SRI index. Thus, the exchange rate risk is diversifiable in the SRI index, implying that investors of SRI index do not attach premium to the exchange rate risk. However, South African socially responsible investors seem to attach risk premium to market and inflation risks. Thus, these investors should consider the impact of inflation rate movements on both the cash flow of companies’ operations and the discount rate employed to value such cash flows when investing in SRI companies.

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The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors’ contributions
Both authors M.F. (North-West University) and P.F.M. (North-West University) contributed academic input to the study and in the writing of the article.

References