BIVARIATE ANALYSIS OF THE CAPITAL ASSET PRICING MODEL IN THE ZIMBABWE STOCK EXCHANGE

Batsirai Winmore Mazviona[1]

ABSTRACT

The knowledge of what risk factors determine investor's return expectations enables investors to evaluate if at any particular point in time the stock or portfolio of stocks that they are considering to invest in or are currently holding is undervalued, overvalued or properly valued by the stock market and therefore make the right buy, sell or hold decision. Participating in the activities of the stock market by investors, raises the following issues; what is the right price to buy or sell a stock. This leads to a question of what are the risk factors that are considered or should be considered by investors in determining the expected rates of return from stocks. This highlights the need to have a suitable model that identifies such risks factors and explains how return expectations are arrived at. Therefore, the problem addressed in this article was the inability of the single-factor Capital Asset Pricing Model (CAPM) to identify the relevant risk factors that investors considered in coming up with their return expectations and the relationships between those relevant risk factors and the return expectations. This study focuses on the ability of the two-factor CAPM with different parameters mainly firm's specific factors namely, market capitalization and the ratio of earnings per share to stock price to explain the variability of stock returns on the Zimbabwe Stock Exchange (ZSE). The ZSE industrial index stock price data after dollarization for the period February 2009 to December 2012 was used for this study. From empirical findings, the proposed risk factors, that is market capitalization and the ratio of earnings per share were not significant in explaining the variability of stock returns on the ZSE.

Keywords: *ZSE, CAPM, risk factors, beta.*

[1]Department of Insurance and Actuarial Science, National University of Science and Technology, P.O Box AC 939 Ascot, Bulawayo, Zimbabwe, Email: winmoreb@gmail.com Tel: +263 9 282842 Ext 2138

INTRODUCTION

Previous studies reveal that there exist a strong relation between book to market equity and average return for Japanese stocks (Chan, Hamao and Lakonishok, 1991). Capaul, Rowley and Sharpe (1993) observed a similar book to market equity effect in four European stock markets and in Japan. Empirical work by both Banz (1981) and Reinganum (1981) has demonstrated that firm-size (market capitalisation) data can be used to create portfolios that earn abnormal returns of up to 40 percent annually and the smaller the firm's capitalization, the greater the apparent abnormal returns. These results appear to be inconsistent with the traditional single-factor Sharpe-Lintner CAPM, which posits a specific relationship between systematic risk (beta) and required asset returns. Basu (1977) found that returns on stocks with high earnings to price ratios tended to be larger than warranted by the underlying risk and vice versa. In a later study by Ball (1978), earnings to price ratio was found to be an important factor in explaining asset returns. The studies revealed that CAPM's beta was not a good determinant of the expected return of stocks or portfolios. Ross (1976) developed the Arbitrage Portfolio Theory (APT) which was both simpler and also had fewer and more realistic assumptions as compared to CAPM. APT does not specify how many factors should be used to explain returns and what these factors should be. These factors may also differ from one period to the next. There could be an interest rate factor, an exchange rate factor, economic growth factor and soon. The return on the market portfolio might also serve as one of the factors. Dash and Rao (2009) conducted a study to compare and assess the applicability of the CAPM and APT in Indian capital markets, and to find out how macroeconomic variables affect the returns of different securities. They studied a sample of 50 stocks listed on the National Stock Exchange, belonging to eightmost flourishing industries in the Indian economy. The results of the study showed that the APT does not have a significantly better explanatory power over the CAPM for Indian capital markets. The validity of CAPM has been subjected to argument since some empirical tests have not been supportive of the model and have recognized a number of factors that tend to better explain the cross-sectionof average returns in addition to market risk as measured by beta. From the late 1970s and onwards evidence against the CAPM started emerging in the anomalies literature. Anomalies in asset pricing are empirical results that seem to be contradictory with maintained theories of asset pricing behaviour. An anomaly in an asset-pricing model is the presence of a statistically significant difference between the observed average returns of an asset and the returns that are predicted by a particular asset-pricing model. The cause of these anomalies can either be market inefficiency or misspecification of the asset pricing model. Reinganum (1981) and Ball (1978) found that anomalies are caused by model misspecification rather than market inefficiency. Empirical literature, dealing with the anomalies of CAPM, test the existence and relative importance ofvarious factors other than beta, which significantly explain the variation in asset returns. The next section provides literature on the anomalous factors considered in modeling asset returns.

RELATED LITERATURE

THE SIZE EFFECT

Research on the impact of size (measured as market capitalisation) on expected returns can be traced to the pioneering works of Banz (1981) and Reinganum (1981). Banz (1981) tested the CAPM by checking whether the size of firms can explain the residual variation in average returns across assets that remain unexplained by the CAPM's beta and challenged the CAPM by demonstrating that firm size does explain the cross-sectional variation in average returnson a particular collection of assets better than beta. These studies found a significant negative relationship between size of a firm and the expected returns. Banz also provided the initial evidence that the size effect is not linear in the market value, that is, the size effect on the asset returns is more significant for very small firms, while there is little difference in returns between average-sized and large firms. Banz conjectured that the size effect might be due to the insufficient information available on small firms'assets leading to limited diversification in these firms resulting in higher risk adjusted returns onthe stocks of small firms. Reinganum (1981) tested the relationship between size of a firm and its returns and found that the size of a firm did explain the residual variation in asset returns not explained by the CAPM's beta. Fama and French (1992) confirmed Banz's findings and identified firm size and the book to market equity ratio as the most important factors in explaining the variation of asset returns. Chan, Chen, and Hsieh (1985) found that size is likely to capture some dimension ofrisk. They found that the earning prospects of small capitalization firms are more sensitive to macroeconomic risk factors than are those of large capitalization firms, in particular, they seem to be more exposed to production risks and changes in the risk premium. Chan and Chen (1991) have argued that size effect is due to the fact that small stocksinclude many martingale or depressed firms whose performance is sensitive tobusiness conditions.Furthermore, Chan and Chen (1991) found that there is a significant relationship between expected return of stock in Tokyo Stock Exchange for the period 1971 to 1988 and the underlying behavior of four variables including earnings yield, size, book-to-market ratio and cashflow yield. Fama and French (1993) found that return is more precisely estimated by model consisting of the three factors namely market risk, size and ratio of book-to-market value of equity. Van Rensburg and Robertson (2003) stated that efforts to empirically authenticate the predictions of the CAPM had produced numerous inconsistencies with the theory. Most notable is the evidence that other variables such as book to market ratios, market capitalisation, earnings to price ratios and leverage are able to predict asset returns beyond that explained by beta. The evidence presented in their study showed that small size earns a higher return on the Johannesburg Stock Exchange but has a lower beta. It was further documented that portfolios containing shares with higher earnings to price ratios earn higher average returns but have lower betas. Drew, Naughton, and Veeraraghavan, (2004) tested the Sharpe-Lintner CAPM and a multifactor model on the Shanghai Stock Exchange and found that the multifactor model performs better and that firm size and idiosyncratic volatilities notably affect stocks return. Theriou et al. (2005) investigated the ability of beta as well as firm specific factors to explain the expected return in the Athens Stock Exchange during the period 1993 to 2001 and their results indicated that there was no significance relationship between beta and the expected return although the firm size effect on the average stock returns was more significant. Cremers, Nair and John (2009) explored the significance of additional factors like size, value, leverage and earnings to price ratio on the Indian stock market during the period 1993 to 2004 and their findings revealed that firm size and value are significant factors anomalous to CAPM.

VALUE EFFECT

Early evidence suggesting the relevance of value (book to market equity) for returns of U.S. stocks was provided by (Stattman, 1980; Rosenberg, Reid and Lanstein, 1985). They investigated the significance of value in explaining the variation in asset returns. They found that value was positively related to expected returns indicating that book to market equity provided valuable information to investors wishing to earn higher returns than those associated to that particular level of risk as measured by beta. Chan and Chen (1991) confirmed the positive relationship between book to market equity and stock returns on the Japanese market. They attribute the value effect to the difference in structural characteristics of small and large firms. They found that the small firms were mostly firms that were less efficiently run, or had not been doing well and were characterized by higher financial leverage. Small firms were more likely to be riskier than large firms, which are not likely to be captured by a market index heavily weighted towards large firms, as a result of the difference in leverage, production efficiency, and perhaps the resulting difference in accessibility to external financing. In a nutshell, smaller firms depicted higher book to market equity and higher expected returns, indicating a positive relationship between value and return. Fama and French (1993) assessed the impact of size and value effect in addition to beta on expected returns in a three-factor model, mentioned earlier and they found that abnormal returns from this three-factor model were not very different from zero when portfolios were formed by sorting stocks according to value, size, earnings to price ratios or dividend yield. This also highlighted significance of factors other thanbeta in explaining expected returns. Fama and French (1995) revealed evidence that size and book to market equity not only proxied for the risk factors that helped to explain cross-sectional variation in common stock returns but were also related to profitability and they argued that similarly to size, book to market equity also captures some dimension of financial distress risk. Book to market equity seems to be related to the operating performance of a company. Firms with higher book to market equity (a low stock price relative to book value) were inclined to be persistently distressed. Penman (1991) and Fama and French (1995) showed that book to market equity firms exhibit persisting higher profitability than high book to market equity ones, that is, book to market equity is inversely related to long-term differences in profitability and their findings supported the hypothesis that in a rational market long-term rather than short-term variation in profitability will affect stock price. They also suggested existence of a size factor in fundamentals, which might lead to a size related risk factor in returns, consequently leading to lesser profitability in smaller stocks within each book to market group compared to larger stocks. Davis, Fama and French (2000) found the apparent premium associated with value stocks in the pre-1963 data to be similar to the post-1963 period examined by Fama and French (1993) and they also found that the size effect being subsumed by value effect in their pre-1963 sample period. Griffin and

Lemmon (2002) also revealed that the returns required on firms exposed to high distress risk had greater sensitivity to a unit change in the book to market equity of these firms than do the returns of non-distressed firms.

EARNINGS TO PRICE RATIO EFFECT

Future returns on high earnings to price ratio stocks were higher than those predicted byt he CAPM when common stocks were sorted on the basis of earnings to price ratios, (Basu, 1977). In a later study, not only was earnings to price found to be a significant factor in explaining asset returns but it was also seen that earnings to price ratio contains information on all factors not explained by the CAPM (Ball, 1978). Reinganum (1981) found that earnings to price ratio subsumes the effect of size on asset returns. However, it was concluded that neither earnings to price ratio nor size can be considered to explain the variation in expected returns and both variables were just proxies for more fundamental determinants of expected returns for common stocks (Basu, 1983). Reinganum's (1981) observed that returns are more closely related to size than to earnings to price ratio is because of not controlling for the effect of risk. In a study by Fama and French (1998), found that the price ratios that produce problems for the CAPM in the United States of America data show up in the same way in the stock returns of twelve major markets which are not in the United States of America, and they are present in emerging market returns as well and evidence suggests that the contradictions of the CAPM associated with price ratios are not sample specific. Ratios involving stock prices have information about expected returns missed by market betas. A stock's price depends not only on the expected cash flows it will provide, but also on the expected returns that discountthe expected cash flows back to the present. Therefore, in theory, the cross-section ofprices has information about the cross-section of expected returns, (a high expected return implies a high discount rate and a low price). The cross-section of stock prices is, nevertheless, arbitrarily affected by differences in scale (or units). But with a careful choice of scaling variable Y, the ratio Y/price can reveal variations in the cross-section of expected stock returns. Such ratios are principal candidates to expose shortcomings of asset pricing models. In the case of the CAPM, shortcomings of the prediction that market betas suffice to explain expected returns (Ball, 1978). Fama and French (1992) updated and synthesized the evidence on the empirical failures of the CAPM and they confirmed that size, earnings-price, debt-equity and book to market ratios added to the explanationof expected stock returns provided by market beta using the cross-section regression approach. Fama and French (1996) reached the same conclusion using the time-series regression approach applied to portfolios of stocks sorted on price ratios and they also found that different price ratioshave much the same information about expected returns. Mixed results have been yielded by empirical tests on CAPM conducted so far, as seen from the literature review, largely indicating the inapplicability of the model in its original form. However, the tests mainly uphold the basic risk and return principle underlying CAPM theory.

DESCRIPTION OF DATA

The study uses weekly stock returns for the sampled 65 stocks listed on the ZSE for the period 19 February 2009 to 31 December 2012. The data were obtained from the ZSE. The time series data for market capitalisation and earnings to price ratios were obtained from audited financial statements and are annual infrequency. In order to obtain better estimates of the value of the beta coefficient, the study used weekly stock returns because returns calculated using a longer time period, for example, monthly might result in changes of the beta coefficient. This would create biases in beta estimation over the sample period. On the other hand, high frequency data such as daily returns covering a relatively short and stable time span might result in the use of very noisy data and thus yield inefficient estimation. Only the capital gains component was used in estimating returns. Ignoring dividends did not pose a serious estimation bias in the light of the fact that the publicly listed Zimbabwean companies exhibited very low dividend yield ratios over the sample period. Furthermore, the Zimbabwean Industrial Index that was used as proxy in the study did not incorporate dividends hence including dividends while estimating stock returns would actually have introduced a positive bias in the slope estimates of the regressions. The industrial market index was used as a proxy for the market portfolio as it comprised of all the stocks in the sample data.

HYPOTHESIS

The main objective of this article is to ascertain the relevant risk factors that determine returns and the following hypothesis is formulated:

H_0: The CAPM explain returns on the ZSE better than the two-factor model that uses market capitalization and earnings price ratio as risk factors.

H_1: The two-factor model based on market capitalization and earnings price ratio explain stock returns expectaions on the ZSE better than the CAPM.

RESEARCH METHODOLOGY

BIVARIATE ANALYSIS OF CAPM

The article main purpose was to test the existence of factors other than the CAPM beta that significantly explained stocks' returns in the ZSE. The factors considered were market capitalisation and the ratio of earnings to price. The methodology of Fama and French (1992) was used. The betas were calculated and portfolios were formed, for the investigation of the effect of the two-factor CAPM during the testing periods, 2011 and 2012. Cross-sectional regressions were run for the portfolio returns as

the dependent variable against the beta and the mentioned factors as the independent variables as explained by the equation below;

$$R_p = \lambda_0 + \lambda_1 \beta_p + \lambda_2 \beta_i + \varepsilon_p \quad \text{..... (1)}$$

Where;

R_p is the portfolio return

β_i is the proxy for factor i

ε_p is the random disturbance term in the regression equation.

The proxies for the risk factors are the natural logarithm of the product of market shares and end of year prices was the proxy for market capitalization and the ratio of the earnings per share to the end of year prices was a proxy for the earnings to price ratio. If each of the mentioned factors are relevant in explaining asset returns on the ZSE, then the estimated parameter λ_2 should be significantly different from zero.

The bivariate analysis allowed for the testing of the following hypotheses about CAPM;

H_{10}: $\lambda_2 = 0$, that is, market capitalisation and earnings to price ratio had no effect on expected returns.

Statistical tests were also carried out to examine the ability of the two-factor CAPM to explain asset returns. A 5% level of significance was also chosen to indicate if the data was good enough to support the hypothesis.

EMPIRICAL FINDINGS

EMPIRICAL ANALYSIS OF PERIOD 1

The tests for the ability of the firm specific factors, that is, market capitalisation and earnings to price ratio, to explain the variation in stock returns was carried out using equation 1 and data from 2010 and 2011. Table 1 below shows the results for the test for 2011.

Table 1: Bivariate analysis results

		Parameter	standard error	t-value	p-value
Market capitalisation test	λ_0	6.823	3.505	1.947	0.109
	λ_1	-0.547	0.466	-1.175	0.293
	λ_2	-0.331	0.184	-1.795	0.133
EPS per price ratio test	λ_0	-0.191	0.654	-0.292	0.782
	λ_1	0.102	0.751	0.136	0.897
	λ_2	2.549	1.632	1.562	0.179

TEST FOR THE EFFECT OF MARKET CAPITALISATION

The results for the bivariate analysis for period 1 showed that the value for λ_0, λ_1 and λ_2 were not significantly different from zero since their p-values were all greater than 0.05. If the CAPM hypothesis is true then λ_0 should be equal to the risk free rate, λ_1 should be equal to the market risk premium and λ_2 should be equal to zero. Therefore, the results for λ_0 and λ_1 were contradictory to the hypothesis and H_{10} was not rejected at 5% level of significance. The results for period 1 indicated that firm size, that is, market capitalisation, did not explain the variation in portfolio returns during the period. The two-factor model did not reveal any superior results in explaining portfolio returns than the single-factor model (CAPM), therefore the results showed evidence in support of CAPM.

TEST FOR THE EFFECT OF EARNINGS TO PRICE RATIO

The results indicated that the value of λ_0 was not significantly different from zero since its p-value, 0.782, was greater than 0.05. The result contradicted CAPM. The p-value for λ_1 was greater than 0.05 hence its value was not significantly different from zero, contradicting the CAPM hypothesis. The p-value for λ_2, 0.179, was greater than 0.05,

hence its value was not significantly different from zero and H_{10} was not rejected. The results revealed that earnings to price ratio did not have an effect on portfolio returns during the period and therefore provide evidence in support of CAPM.

EMPIRICAL ANALYSIS OF PERIOD 2

The same approach was used for 2012, that is, period 2. The results of the tests are tabulated below;

Table 2: Bivariate analysis results

		Parameter	standard error	t-value	p-value
Market capitalisation test	λ_0	-0.535	2.392	-0.224	0.832
	λ_1	0.183	0.288	0.633	0.554
	λ_2	0.005	0.121	0.039	0.970
EPS per price ratio test	λ_0	-0.005	0.001	-4.540	0.006
	λ_1	0.001	0.003	0.214	0.839
	λ_2	0.000	0.001	-0.568	0.595

TEST FOR THE EFFECT OF MARKET CAPITALISATION

The period 2 results indicated that λ_0 and λ_1 were not significantly different from zero contradicting the CAPM hypothesis. The p-value for λ_2, 0.97, was greater than 0.05 thus its value was not significantly different from zero, thus H_{10} was not rejected. These results provided evidence in support of CAPM since the firm specific factor, market capitalisation, could not explain the variation in portfolio returns.

TEST FOR THE EFFECT OF EARNINGS TO PRICE RATIO

The p-value of λ_0 was less than 0.05, hence its value was significantly different from zero. The result was in support of the CAPM hypothesis. The value of λ_1 was not significantly different from zero since its p-value was greater than 0.05, thus contradicting CAPM. The p-value of λ_2, 0.596 was greater than 0.05, therefore it was not significantly different from zero and H_{10} was not rejected. Period 2 results revealed that earnings to price ratio did not explain the variation in portfolio returns, thus providing evidence in support of CAPM. Period 1 and period 2 results both revealed that market capitalisation and earnings to price ratio did not affect expected portfolio returns, thus providing evidence in support of CAPM.

CONCLUSION

The findings from this article based on bivariate analysis revealed that the size, that is, market capitalisation and earnings to price ratio did not explain the variability in expected portfolio returns, thus supporting the CAPM hypothesis. Manjunatha and Mallikarjunappa (2009) obtained similar results from their study of the validity of CAPM on the Indian capital market. Fama and French (1993) investigated the ability of a three factor model, with value, size and dividend yield as the risk factors, to explain stock returns and it was proved to be a superior model to the CAPM, hence the researcher would like to recommend a further study in the ability of various risk factors such as firm value, that is, book to market equity, dividend yield, interest rates, inflation and Gross Domestic Product to determine stocks' returns on the ZSE.

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