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An Empirical Test of the Validity of the Capital Asset Pricing Model on the Zimbabwe Stock Exchange

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ABSTRACT

We test the empirical validity of the capital asset pricing model (CAPM) on the Zimbabwe Stock Exchange (ZSE) using cross-sectional stock returns on 31 stocks listed on the ZSE between March 2009 and February 2014. We conclude that, although the explanatory power of beta tends to fall rapidly for prediction horizons >6 months, beta significantly explains average monthly stock returns on the ZSE. Tests to validate the CAPM reject its validity for the ZSE however, primarily due to liquidity and skewness anomalies. We nevertheless fail to detect any size effects. There is encouraging evidence to suggest that the CAPM performs reasonably well in predicting average monthly returns over prediction horizons of between 3 and 6 months. We recommend that investors and analysts must exercise extreme caution in applying the CAPM. Furthermore, we discourage strategies based on the existence of a size premium on the ZSE. Instead, investors may consider neglected and negatively skewed stocks, albeit over appropriate horizons. Further research on other African Stock Markets will help verify if the optimal performance range of the CAPM is indeed 3-6 months. Development of standard continental proxy market portfolios will also improve the estimation of betas and enhance results of cross-country tests of the CAPM.

Keywords: Capital Asset Pricing Model, Beta, Capital Asset Pricing
JEL Classification: G12

1. INTRODUCTION

Fama and French (2005) have called the practical usefulness of the capital asset pricing model (CAPM) into question in view of substantial anomalous evidence in the 1980s and the 1990s. If the position taken by Fama and French (2005) on the CAPM is anything to go by, then we should be seeing some movement away from the use of the CAPM in favor of other models such as arbitrage pricing theory. However, especially in Zimbabwe, the CAPM continues to be a dominant tool for asset pricing and investment decision-making, and a very popular model in most university finance curricula. More interesting is the paucity of research on the validity of the model on the Zimbabwe Stock Exchange (ZSE) and on other African Stock Markets. The CAPM is literally taken as given. This gives rise to the need for further research to verify if the continued popularity of the CAPM has empirical backing from the ZSE.

The CAPM is an asset pricing model which uses beta as its only measure of risk; hence it is usually referred to as a single index model. The model is built on modern portfolio theory developed and formalized by Markowitz in 1952. The standard version of the CAPM, as developed by Sharpe (1964) and Lintner (1965), relates the expected rate of return of an individual security to its beta risk. One property of the CAPM is that investors are compensated with a higher expected return only for bearing beta risk. Thus, the CAPM suggests that higher-beta securities are expected to give higher expected returns than lower-beta securities because they are more risky (Elton and Gruber, 1995).

Earlier studies such as Black et al. (1972) offer strong support to the CAPM. After analyzing returns on portfolios of different securities at different levels of beta for the period 1926-1966, they find that in general there is a positive simple relation between average return and beta. Fama and Macbeth (1973) report similar findings. Blume and Friend (1973) confirm the linearity of the relationship between risk and return for New York Stock Exchange (NYSE) stocks over three different periods of the Second World War.

However, later studies done in the mid-1970s up to the early 1990s show that, while the CAPM offers useful insights to investors, it fails to explain a considerable amount of return variation among stocks. In what is now commonly known as "the anomalies literature," it has been shown that there are other factors apart from beta that explain cross-sectional return variations. For example, studies have found that factors such as size (Banz, 1981; Fama and French, 1992; 1993; 1996), book to market (B/M) value ratio (Rosenberg et al., 1985), macro-economic variables (Chan, 1997), and the price to earnings (P/E) ratio (Basu, 1977) have significant explanatory power.

In spite of the evidence against it, the CAPM remains resilient more than 40 years after it was developed. While the sustained academic and practical popularity of the CAPM may be typically attributed to its simplicity and clarity, it is also true that competing models have not done a good job of dislodging the CAPM based on scientific evidence. Because users of the CAPM are so accustomed to the model, it will take a lot of convincing evidence to dismiss it, more so given that there are still studies that yield evidence in support of the CAPM in recent years. For instance, Hasan et al. (2013) confirm that the "expected return-beta" relationship is linear in portfolios and unique risk has no effect on the expected return of portfolios. Köseoğlu and Mercangoz (2013) also conclude that both the standard CAPM and the zero-beta CAPM are valid on the Istanbul Stock Exchange in Turkey.

The purpose of this study is to verify the empirical validity of the CAPM on the ZSE for the period from March 2009 to February 2014. Specific objectives of the study include: (1) To propose a more refined procedure for estimating stock betas on the ZSE; (2) to determine the sufficiency of beta risk in explaining differences in stock returns on the ZSE; and (3) to examine the performance of the CAPM in explaining average stock returns beyond the one period prediction horizon.

In this study, we attempt to answer five important empirical questions: (1) Does beta significantly explain stock returns on the ZSE? (2) Is the size effect present on the ZSE? (3) Do differences in the liquidity of stocks explain differences in stock returns on the ZSE? (4) Do higher moments have return prediction power on the ZSE? (5) How does the explanatory power of beta change as the return prediction range is increased?

We test the hypothesis that the CAPM is empirically valid for the ZSE against the alternative hypothesis that the CAPM is not empirically valid for the ZSE.

This study is a useful contribution to extant empirical literature on the CAPM because it reveals new insights on the instability of the explanatory power of beta. More specifically, we show that the explanatory power of beta is a concave function of the length of the prediction period. Whereas the debate on the empirical confirmation of the CAPM may never be settled in view of Roll's critique (Roll, 1977), the search for evidence on the CAPM is an ongoing exercise. Because the CAPM continues to be widely used in applications, existing empirical evidence on the model remains contestable. The anomalies uncovered in empirical data since the early 1990s have been attacked by some as mere results of survival bias in samples (Kothari et al., 1995) or a result of beta estimation errors, and by others as outcomes of investor irrationality. In this study, we improve the quality of empirical evidence on the CAPM by refining the methodology for estimating beta hitherto employed in CAPM tests on the ZSE (i.e., Mazviona, 2013; Jecheche, 2011). We extend the beta estimation technique in Fama and French (1996) by incorporating the Bloomberg adjustment. This should significantly improve the stability of estimated betas and make them good proxies for future betas. In addition, we answer two new questions that are not addressed in existing research on the ZSE. Firstly, do higher moments explain stock returns? Secondly, is there an optimal prediction horizon for beta? Answers to these questions give new insights on asset pricing and on wider applications of the CAPM.

We base this study on the following set of assumptions: (1) The ZSE is dominated by Markowitz investors; (2) Realized returns are good proxies for expected returns; (3) The Zimbabwe industrial index is a good proxy for the market portfolio; and (4) The Zimbabwe industrial index is mean-variance efficient.

The rest of the paper proceeds as follows: In Section 2 we present a detailed literature review on the CAPM; in Section 3 we detail the methodology of the study; in Section 4 we present the findings of the study along with interpretation; and in Section 5 we conclude the study.

2. LITERATURE REVIEW

2.1. Basic Theory Underlying the CAPM

The CAPM is built on the modern portfolio theory which was initially developed by Markowitz (1952) and Tobin (1958). As developed by Sharpe (1964) and Lintner (1965), the CAPM models the equilibrium expected return on an asset as a positive linear function of its beta risk. In the CAPM world, the only relevant risk measure is systematic risk, as this cannot be diversified away. Investors should be proportionately rewarded for bearing this risk. Beta measures the volatility of a share or a share portfolio and hence estimates how the returns on the share or portfolio will move relative to the movements in the market portfolio (Moyer et al., 2001; Jones, 1998).

By definition, the market portfolio has a beta of one. The beta of a portfolio is the weighted average of the betas of all securities contained in the portfolio. Therefore, portfolios with betas greater than one have higher systematic risk than the market, while those with betas less than one have lower systematic risk. Hence, by adding securities with betas that are higher to a portfolio, we increase the systematic risk of the portfolio and hence shares, or share portfolios with high betas should exhibit high returns and *viz*. (Elton and Gruber, 1995).

The CAPM is symbolized by the security market line (SML), which is a locus of combinations of beta and expected return that represent fair pricing of securities in equilibrium.

The equation of the SML is given thus:

$$ER_i = R_f + B_i(ER_m - R_f) \quad (1)$$

Where: ER_i = Expected return on a share/portfolio; R_f = Risk-free rate of return; β_i = Beta (volatility of the share/portfolio relative to the market portfolio); ER_m = Expected return on the market portfolio.

From the formula (1), it is evident that the model depicts the expected return of a security as a function of the return on a risk free asset plus a risk premium. The theoretical version of the CAPM is an expectations model; hence it utilizes ex-ante returns and expected betas. However, empirical tests of the CAPM use ex-post returns and historical betas, since ex-ante returns are unobservable. Before Sharpe's (1964) and Lintner's (1965) breakthroughs, there were no asset pricing models built from first principles about the nature of tastes and investment opportunities and with clear testable predictions about risk and return.

2.2. Evidence on the CAPM

Empirical tests of the CAPM have generally focused on three implications; firstly, the intercept should be equal to the risk free rate; secondly beta should be the only proxy for the security's risk which completely captures the cross sectional variation of expected returns (Black et al., 1972; Fama and Macbeth, 1973) and the beta-return relationship should be linear; and finally the market risk premium should be positive.

2.2.1. Tests of the CAPM on the ZSE

The ZSE is a small but active stock exchange in Africa. It was established in 1896 and it has been open to foreign investment since 1993. The true forerunner to the ZSE of today was founded in Bulawayo in January 1946, shortly after the end of the Second World War. To date, the ZSE has a lot of members and about 67 listed securities with two indices, the Zimbabwe Industrial Index and the Zimbabwe Mining Index. The Industrial Index is dominated by price movements in a few big cap stocks such as Delta, Econet, Innscor, Barclays and The Commercial Bank of Zimbabwe.

The ZSE operates according to the Stock Exchange Act (Chapter 198). The stocks on the exchange include financial, insurance, retail, construction, transport, pharmaceuticals, property, telecommunications, manufacturing and agricultural-related stocks. Trading is done manually on the ZSE and is conducted on a daily call over that begins at 10.00 am and ends before noon. Settlement is done on a T+7 day basis and is against physical scrip delivery.

Mazviona (2013) and Jecheche (2011) test the validity of the CAPM on the ZSE, and both conclude that the CAPM beta is not significant in explaining stock returns. Mazviona (2013) carried out a study for the period February 2009 to December 2012 for 65 stocks listed on the ZSE. The study uses time series regression and cross-sectional regression to test the relationship between expected return and risk. The study finds no evidence of a significant positive relation between beta risk and return. Instead, the risk premium is found to be negative but statistically insignificant. However, the results of linearity tests confirm a linear relationship between returns and beta coefficients. In addition, non-systematic risk is shown to have no effect on average returns. The conclusion from the study is that the CAPM does not fully hold on the ZSE.

Jecheche (2011) uses monthly stock returns to test the CAPM based on 28 most traded firms listed on the ZSE for the period from January 2003 to December 2008. The study uses the Black et al. (1972) and the Fama and Macbeth (1973) method to test the model on the ZSE. The study does not provide evidence that higher beta yields higher return while the slope of the SML is negative. The study also notes that estimated values for the risk free rate and the beta risk premium differ from their theoretical values. However, the results confirm the linearity of the risk-return relation. On the basis of the negative beta risk premium and the difference between estimated and theoretical values noted above, the study concludes that the CAPM does not hold for the ZSE.

2.2.2. Tests of the CAPM around the world

2.2.2.1. 20th Century evidence on the CAPM

2.2.2.1.1. Evidence in support of the CAPM

Black et al. (1972) test the validity of the CAPM for the period 1926-1966 using all the stocks listed on the NYSE. Based on monthly return data and an equally-weighted portfolio of all stocks traded on the NYSE as their proxy for the market portfolio, they find evidence in support of a significant positive linear relation between beta and expected return. Fama and Macbeth (1973) provide confirming evidence based on a two-pass regression approach. The two-pass regression approach (FM approach) has become a dominant methodology in empirical tests of the CAPM. Further supporting evidence is provided by Blume and Friend (1973), who confirm linearity of the beta risk-return relation on the NYSE over three different periods of the Second World War.

In later tests of the CAPM, Dowen (1988) concludes that security prices are determined by beta because all unsystematic risk would be eliminated by diversification. Although he submits that there is no sufficiently large portfolio that could eliminate non-systematic risk, his results still favor the CAPM, and further suggest that portfolio managers may use beta as a tool, yet not as their only tool. Dowen (1988) also confirms the linear relation between beta risk and return.

Later, Kothari et al. (1995) re-examine the risk-return relation using a longer measurement interval of returns and alternative market data (the Standard and Poor industry portfolios). They present evidence that average returns do indeed reflect substantial compensation for beta risk, provided that betas are measured at an annual interval.

2.2.2.1.2. Evidence against the CAPM

Most research during the 1990s questions the linearity of the beta risk-return relation and the adequacy of beta in explaining cross-sectional returns. Cheung et al. (1993) test the applicability of the CAPM in Asian markets, particularly the Korean and the Taiwan market (Taiwan Stock Exchange). They find that the CAPM beta predictions on average stock returns are weak and that there is no linear relationship between risk and return. Hence they conclude that the CAPM does not hold in both markets. Huang (1997) finds an inverse relationship between returns and systematic risk, unique risk and total risk respectively, in the Taiwan market.

Michailidis et al. (2006) test the CAPM on the Athens Stock Exchange using weekly returns of 100 listed companies. The CAPM prediction that higher risk should yield a higher return is not supported by the evidence. More so, the fact that the intercept has a value of about zero indicates that the zero beta CAPM is not valid.

Basu (1977) observes that low P/E ratio portfolios earn higher absolute and risk adjusted rates of return than those of high P/E ratio portfolios during the period from April 1957 to March 1971. This provides evidence against the CAPM as beta alone fails to explain stock returns. This view is also supported by Lakshmi and Roy (2013), who observe that high P/E ratio portfolios generate negative annual rates of return, whereas low P/E ratio portfolios generate positive annual rates of return. This confirms that P/E ratio information is not fully reflected in security prices in a rapid manner as postulated by the CAPM.

Blume and Husic (1973) find that price is, in some sense, a better predictor of future returns than the historically estimated beta. They express the annual returns in 1969, on the NYSE and the American Stock Exchange, as a function of 1968 year-end price and the historically estimated beta. In order to assess how adequately price measures beta, the correlation between price and historically estimated beta is calculated for American listed securities for each of the years from 1964 to 1968. They find that the correlations are unexpectedly close to zero. Therefore this early study illustrates the more general observation that, while the CAPM may hold true in some markets at some times, it does not hold true in all markets at all times.

Basu (1977) and Banz (1981) report yet another anomaly; the size effect. Their main finding is that small cap counters experience high risk adjusted returns as compared to large cap counters. Hence using beta alone to explain stock returns leads to biased results. The size effect has been thoroughly researched and the results above are quite persistent (Fama and French, 1992; 1993; 1996).

Rosenberg et al. (1985) report that firms with high B/M ratios tend to experience high average returns compared to those predicted by the CAPM model. Their tests prove that there is a positive correlation between the B/M ratio and average returns. This is also supported by Fama and French (1992, 1996), who even suggest that the B/M ratio is more powerful than the size effect in explaining cross sectional average returns. Fama and French (1996) have even argued that evidence on the explanatory strength of beta is not exclusive support for the CAPM since almost all competing asset pricing models incorporate beta as an explanatory variable.

2.2.2.2. 21st Century evidence on the CAPM

Research on the CAPM continues to generate debate even in the 21st century. Despite all the criticism of the model in the 1990s, it is still considered as the backbone of modern-day pricing theory for financial markets and has wide empirical applications in corporate finance and investment management. Some empirical investigations find evidence contrary to the CAPM, while others appear to be in harmony with the principles of the model.

2.2.2.2.1. Evidence against the CAPM

Mateev (2004) tests the validity of the CAPM on the Bulgarian Stock Exchange (BSE). Using the Fama and Macbeth cross sectional method, the study proves that beta, size and the B/M value were priced on the BSE. Hence, other than beta, other variables that had a significant role in explaining the Bulgarian stocks are found. The additional variables are conjectured to be proxies for certain firm-specific characteristics, which beta fails to capture fully, or proxies for certain risks (other than systematic risk), as well as costs. These anomalies observed on the BSE imply that the traditional CAPM does not correctly and adequately describe the price behavior in the Bulgarian stock market, or simply that the market was inefficient.

Fama and French (2004) launch a scathing attack on the CAPM. In a review of the evidence on the CAPM, the two avid critics of the CAPM make strong statements about the appropriateness of the applications of the CAPM in light of the evidence against it. They argue that several anomalies have been verified in most developed markets, and that even in studies that validate the model, the observed relationship between beta risk and return is too flat. Nimal (2006) rejects the linearity of the beta risk-return relation on the Taiwan Stock Exchange.

Dzaja and Aljinovic (2013) test the CAPM using data from Romania, Hungary, Bulgaria, Serbia, Poland, Turkey, Czech Republic, and Bosnia and Herzegovina. They use monthly returns from the period of January 2006 to December 2010. Based on regression analysis, they find that higher yields do not mean higher beta. Also by applying the Markowitz portfolio theory they determine the efficient frontier for each market, and find that the stock market indices do not lie on the efficient frontier and therefore cannot be regarded as a good proxy for the market portfolio, as is usually assumed. The authors conclude that the CAPM beta alone is not a valid measure of risk.

Recently, some studies find that skewness and kurtosis are significant in explaining stock returns. Conrad et al. (2013), for example, find that individual securities' skewness and kurtosis are strongly related to future returns. In their cross sectional regression using the period from 1996 to 2005, they find a positive relationship between kurtosis and subsequent returns. Moreover, they also find that ex-ante negatively (positively) skewed stocks yield subsequent higher (lower) returns.

2.2.2.2.2. Evidence in support of the CAPM

Laubscher (2002) concludes that the CAPM is a useful description of the risk-return relationship on the Johannesburg Stock Exchange (JSE). However, the author posits that investors should be cautious when using the model to evaluate investment performance as other factors may be useful in explaining share returns. Reddy and Thomson (2011) use quarterly returns to test the CAPM on the JSE for the period from June 1995 to June 2009. They use regression analysis to test the validity of the model on both individual sectoral indices and portfolios constructed from the indices according to their betas. They conclude that, on the assumption that the "residuals of the return-generating function are normally distributed," the CAPM could be rejected for certain periods, though the use of the CAPM for long-term actuarial modeling in the South African market can be reasonably justified.

Hasan et al. (2013) use monthly stock returns on the Bangladesh Stock Exchange for the period from January 2005 to December 2009. The all share price index (DSI) is used as the proxy for the market portfolio and the Bangladesh 3 month government treasury bill as the risk free asset. The results of the coefficients of squared beta and unique risk indicate that the expected return-beta relationship is linear in portfolios and that firm specific risk has no effect on the expected return of the portfolios. The intercept terms for the portfolios are not significantly different from zero. These findings support the validity of CAPM.

Köseoğlu and Mercangoz (2013) find that the CAPM holds on the Istanbul Stock Exchange. They confirm the linearity of the beta risk-return relation. In addition, they find that the alpha constants from the estimated models are equal to the risk free rate.

Despite the seemingly overwhelming evidence against the CAPM, which has conveniently become part of the "anomalies" literature, Shiller (2013) argues that we cannot discard the theory; instead the test results should be interpreted with caution as the experiment conducted by the researcher may not even be a true test of the CAPM. This directly leads to a discussion of empirical issues that make the testing of the CAPM difficult, if not impossible.

2.3. Empirical Issues in Tests of the CAPM

Jaganathan and Wang (1993) argue that the empirical failures of the CAPM are sometimes due to basic choices and assumptions researchers make to facilitate the empirical analysis. These include choices pertaining to the proxy market portfolio, testing interval, and beta estimation procedure. Contradictory evidence on CAPM has also been a result of differences, not only in sampling period, but also decision criteria. Some scholars even argue that any test of the CAPM is a joint test of the efficient markets hypothesis and the CAPM equilibrium pricing relation.

2.3.1. Problems with the market portfolio

The CAPM expresses the systematic risk of a security relative to a comprehensive "market portfolio," which should include not just tradable financial assets such as equities and bonds, but also non-tradable assets such as fixed property, consumer durables and human capital (Fama and French, 2004). In the CAPM equation, the investor's expected return is a function of the risk free rate plus a beta risk premium (a function of beta and the market risk premium). The market risk premium is equal to the expected return on the market portfolio less the risk free rate. This market portfolio is the one that should include both the tradable and non-tradable assets and is unobservable in nature. All investors will select the optimal market portfolio, which is the market portfolio because the market portfolio is the one that yields the highest return for a given level of risk in a given investment opportunity set and hence it is not possible to further diversify away risk.

According to Roll (1977), a wrongly specified proxy for the market portfolio can have two effects which are: (i) The beta computed for alternative portfolios would be wrong because the market portfolio is inappropriate, (ii) the SML derived would be wrong because it goes from the risk free rate through the improperly specified market portfolio. Moreover, when comparing the performance of portfolio managers to the "benchmark" portfolios, the above factors will tend to overestimate the performance of portfolio managers as the proxy market portfolio employed will not be as efficient as the true market portfolio such that the slope of the SML will be underestimated.

The argument is that, if the market proxy problem invalidates tests of the model, it also invalidates most applications, which typically borrow the market proxies used in empirical tests (Fama and French, 2004). Hence, to overcome this, some researchers like Hou (2003) have decided to use a hypothetical market portfolio which has gross domestic product as its dividend, while some have attempted to use a broader set of assets to represent their market portfolio.

In response to the above critique, some scholars argue that although the equally weighted stock market index is not a true reflection of the market portfolio, it should be highly correlated with the true market portfolio (Shanken, 1987; Kandel and Stambaug, 1987). Nonetheless, even those who have tried to use a broader set of assets like bonds and properties, amongst others, to construct a market proxy, still find little evidence in support of the CAPM.

2.3.2. Sample period and estimation interval

The sample period used when testing the model has an effect on the findings, hence researchers must take cognizance of the time horizon used when interpreting results especially if it is short. This is evidenced by the work of Choudhary and Choudhary (2010) and Diwan (2010). The two studies test the validity of CAPM on the Bombay Stock Exchange in India, yet they arrive at different conclusions. Diwan (2010) uses weekly stock returns for the period from November 2004 to October 2009. The study uses a window of 53 weeks to regress the weekly returns of the listed stocks on the weekly returns of the SENSEX30 index. When non-linearity tests are run, it is shown that the CAPM adequately explains excess returns. Thus, the study confirms the linear structure of the CAPM equation; hence the work concludes that the CAPM holds on the BSE.

On the contrary, Choudhary and Choudhary (2010) conduct a study based on 278 companies listed on the exchange for the period from January 1996 to December 2009 and conclude that the CAPM does not hold on the BSE. This is despite evidence suggesting the CAPM does explain excess returns, which supports the linear structure of the CAPM equation. They allude to the fact that the theory's prediction for the intercept is that it should equal zero and the slope should equal the excess returns on the market portfolio.

Reilly and Brown (2011) suggest that beta is a fickle short term performer; hence some short term studies have shown that the beta-return relationship is negative, which suggests that: (i) In some short periods, investors may be penalized for taking on more risk; (ii) in the long-run, investors are not rewarded enough for bearing on more risk and are compensated for buying securities with low risk; and (iii) in all periods, some systematic risk is being valued by the market.

Therefore, the period used in the testing of the CAPM should be long enough to nullify all short-term surprises, for beta coefficients to take long-term values or for beta coefficients to adjust to their long-term values.

2.3.3. Problems with the estimation of beta

The beta of an asset is the most important concept since it captures that aspect of investment risk which cannot be eliminated by diversification. In many tests, historical betas are used to estimate future betas hence one wonders if historical betas are good estimates to use in an expectations model. This is because one may propose that history does not repeat itself in the same and exact manner.

It has been found that beta is generally volatile for individual stocks but stable for portfolios of stocks over a long period of time (Grinblatt and Titman, 2002). Miller and Scholes (1972) highlight the statistical problems encountered when using individual securities in testing the validity of the CAPM, while Fama and French (2004) observe that beta estimates for individual assets are imprecise and hence create a measurement-error problem when used to explain average returns. Hence, the use of portfolios rather than individual securities has been proven to yield better results on the stability of beta and improve the precision of the CAPM beta. The portfolios are arranged by the order of their betas, with the first portfolio containing equities with the lowest betas and the last containing those with the highest betas. Lau et al (1974) find that such grouping "greatly (reduced) the standard errors on both the intercept and the slope of the … regression."

The debate between Fama and French (1996) and Kothari et al. (1995) adds an interesting dimension to the beta estimation debate. While Kothari et al. (1995) argue that using annual returns yields better beta estimates, Fama and French (1996) contend that there is no reason to believe that annual returns do better than monthly returns. However, the use of monthly returns has become standard in the literature.

3. RESEARCH METHODOLOGY

3.1. Sampling Criteria and Description of Data Used

We use monthly return data for 31 companies listed on the ZSE, covering the period from 3 March 2009 to 28 February 2014. Thus, we utilize a total of 60 monthly return observations for each of the companies in the sample. The first 48 months serve as the estimation period and the next 12 months constitute the model-testing period. The choice of sample period is informed by a number of factors. Firstly, we exclude the period before 3 March 2009 to treat potential bias resulting from thin trading on the ZSE. The ZSE opened for trading in US dollars in mid-February 2009, thus investors took some time to arrive at fair valuations of companies under the new monetary dispensation. The choice of February 2014 as the ending time is justified by the need to have a round number of months in the estimation and test period, i.e., 60 months.

The exclusion criteria for determining the composition of the study sample are as follows: Firstly, we exclude mining companies from the study since there are only four listed mining companies on the ZSE. The inclusion of mining companies would require the use of the mining index as a market proxy in addition to the industrial index, which is the main index on the ZSE. Their exclusion has a minimal effect on the results of the study, given that they constitute only about 6% of companies on the ZSE. This reduces eligible companies from 67 to 63. Secondly, we exclude 25 counters that had not started trading by March 3, 2009, thus reducing eligible counters further to 38. This prevents distortion of results due to inclusion of non-trading counters, which would naturally carry a series of zeros. Thirdly, we exclude four counters that were suspended sometime during the study period. This ensures data continuity but reduces the eligible counters to 34. Fourthly, we exclude two counters that experienced stock splits and consolidations (Econet and NMBZ respectively), taking down the number to 32. Lastly, we leave out one counter with a negative beta (ABCH), bringing the final study sample to 31 (Appendix 1 for all excluded stocks).

We use the industrial index as the proxy for the market portfolio on the basis that about 94% of stocks listed on the ZSE are industrial stocks. In recognition of the existence of infrequent trading of most small counters on the ZSE, we use monthly returns in this study. While there is no solid empirical evidence to suggest that monthly returns result in better estimates of stock betas than either daily or yearly returns, we adopt monthly returns in view of their widespread use in the empirical literature (e.g. Fama and French, 1992; 1993; 1996). Furthermore, given that only 5 years of data are available for both estimation and testing, monthly returns give more observations for the time series regression estimation of stock betas.

3.2. Specification of Variables

3.2.1. Dependent variables

We use monthly log returns on stocks as the dependent variable in the time-series-based beta estimation procedure and average monthly log returns on stocks as the dependent variable in the cross-sectional regression model. The use of monthly returns is informed by prior studies and is also in recognition of the fact that there may be a lagged reaction of small firm returns to market ret urns (Grinblatt and Titman, 2002), which would make the use of more frequent returns problematic. Additionally, the use of yearly data would mean that only a few data points would be used (since data is only available for 5 years), and this would result in poor estimation results from the regressions.

3.2.2. Independent variables

The first set of regressions in this study estimates stock betas using time series data on stocks and the industrial index. According to the market model, stock returns are theorized to depend linearly on market returns. As such, we use the monthly return on the industrial index as an independent variable in the time series regressions. Furthermore, in recognition of the potential for a lagged adjustment of small stock returns to market returns noted above, we include a lagged monthly log return as a second independent variable in the beta estimation regressions. This allows for a better estimation of betas, since the existence of a lagged adjustment results in underestimation of betas (Grinblatt and Titman 2002).

In the cross-sectional regression (test regression) on stocks, we use more independent variables. These include; adjusted stock beta, capitalization (size) ratio, liquidity ratio, skewness, and excess kurtosis. Beta is the only determinant of returns if the CAPM holds. We include the size factor to control for size effects that have been documented in the empirical literature (Basu, 1977; Fama and French, 1992). However, we do not test for other anomalies documented in the literature such as the P/E ratio and the book-to-market value effects due to data challenges. Instead, we introduce a liquidity factor as an additional idiosyncratic control variable to test for thin trading effects, given that thin trading is a concern in most empirical studies on small stock exchanges. We estimate the liquidity factor as the average percentage of outstanding shares traded per month for the entire 48 months used in the estimation.

While the literature has predominantly tested for linearity in the beta-return relation by incorporating a squared beta component, we depart from this norm. This is in recognition of the high correlation between beta and squared beta, which would unreasonably understate the statistical significance of beta. Instead, we test if the third and fourth moments of the return distribution (i.e., skewness and kurtosis respectively) have any empirical explanatory power. The explanatory power of skewness and kurtosis is part of a recent strand of literature that documents that investors consider higher moments when making investment decisions (Conrad et al., 2013). In particular, Conrad et al. (2013) document a significant negative relation between skewness and expected stock returns.

3.3. Estimation Procedures

3.3.1. Estimating stock betas

To estimate stock betas, we first derive monthly log returns from daily price data for each of the stocks, and for the industrial index. We then conduct time series regressions of stock returns versus the industrial index returns. In recognition of the fact that small firm returns may react to market returns with a lag, and hence cause a downward bias in beta estimates, we include lagged index returns in addition to the contemporaneous index returns to estimate beta (Fama and French, 1996).

The estimated regression equation is of the form:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{mt} + \beta_{2i} \mathrm{R}_{m(t-1)} + \varepsilon_{it} \quad (2)$$

Where:

R_{it} = Observed monthly log return for stock in month t;

R_{mt} = Observed monthly log return on the market index in month t;

$\mathrm{R}_{m(t-1)}$ = Observed monthly log return on the market index in month $t-1$;

β_{0i} = Regression intercept;

β_{1i} = Regression slope coefficient for the contemporaneous index return;

β_{2i} = Regression slope coefficient for the lagged index return;

ε_{it} = Random return for stock i in month t;

We find the raw beta of stock i by adding the values of β_{1i} and β_{2i} (the partial regression slope coefficients).

Thus,

$$\beta_{raw} = \beta_{1i} + \beta_{2i}$$

To get the adjusted beta, we adjust the raw beta using the Bloomberg adjustment formula that takes into account the tendency for betas to regress to unity over time (mean reversion). The effect is that betas below 1 are adjusted upwards, while betas above 1 are adjusted downwards. The adjustment formula is as follows:

$$\beta_{adj} = \frac{2}{3} \times \beta_{raw} + \frac{1}{3}$$

Where: β_{adj} = Adjusted beta; β_{raw} = Raw beta.

The beta estimation procedure above is a significant improvement on existing studies on the ZSE, which use raw betas and do not make a lag adjustment (Mazviona, 2013; Jecheche, 2011).

3.3.2. Estimating average monthly log returns

The estimation of average monthly log returns is made easy by the fact that log returns are additive over time. First, we add the monthly log returns for each stock for all the months in the sample period to get the cumulative log return. We then divide the cumulative log return by the number of months in the estimation period to get the average monthly log return.

Thus,

$$\overline{R}_i = \frac{1}{n}\sum_{t=1}^{n} R_{it}$$

Where:

$\overline{R_i}$ = Average monthly log return for stock i;

R_{it} = Observed monthly log return for stock i in month t;

n = Total number of monthly log returns.

We use the above procedure to estimate average monthly returns for both the estimation period and the test period. A point to note is that in the test period however, we calculate average forwardlooking monthly returns on a rolling basis. Thus, the value of n in the above formula ranges from 1 to 12. For example, to determine the average monthly return for the first 6 months of the test period, we add the log returns for months 1-6 and divide the sum by 6. Thus, the test period has a total of 12 successive monthly average returns. We do this to test for any changes in the explanatory power of the test variables, especially beta, as the prediction horizon increases from 1 to 12 months. This aspect is missing in studies by Mazviona (2013) and Jecheche (2011) on the ZSE.

3.3.3. Estimating capitalization ratios for stocks

We determine the capitalization ratios (size factors) for stocks relative to the median firm in the sample, where dollar capitalization values are taken as average capitalization values for the estimation period (48 months in this case). We use the median firm instead of the average firm in the sample to reduce the impact of outliers. Since there are very large as well as very small firms in the sample, the median is the best measure of central tendency. This measurement of the size factor is a notable departure from the literature.

Thus,

$$S/F_i = \frac{MK_i - MK_m}{MK_m}$$

Where:

S/F_i = Size factor for stock i;

MK_i = Average dollar market capitalization for stock i;

MK_m = Average dollar market capitalization for the median stock in the sample.

3.3.4. Estimating liquidity ratios for stocks (L/F)

We find liquidity ratios for individual stocks by dividing the average monthly volume of shares traded by the average total outstanding shares for the estimation period.

Thus,

$$L/F_i = \frac{AMTV_i}{ATS_i}$$

Where:

L/F_i = Liquidity ratio for stock i;

$AMTV_i$ = Average monthly traded volume for stock i;

ATS_i = Average total shares outstanding for stock i.

3.4. Testing Procedures

3.4.1. Cross-sectional regressions

While it is almost standard in the literature to use portfolios for the cross-sectional regression, ostensibly to moderate beta estimation errors in individual stock betas, we use individual stocks for a number of reasons. Firstly, and most importantly, the sample has only 31 stocks, which makes it impossible to construct a large sample of portfolios to use in cross-sectional tests. Only 10 portfolios can be constructed using only 3 stocks per portfolio. This is far short of the minimum of 30 portfolios needed for reliable statistical tests. Besides, the combination of 3 stocks in a portfolio would not result in adequate reduction in the standard error of beta estimates. Secondly, the sample period is too short to allow implementation of the procedure in Fama and French (1992; 1993; 1996), which enables generation of more portfolio observations. Thirdly, we have taken measures to improve beta estimation by incorporating lagged adjustment and mean reversion in the beta estimation procedure. On the basis of the preceding, we submit that the use of individual stocks is sufficient to generate relevant insights on the CAPM.

To test whether CAPM holds or not, the following cross-sectional regression is used:

$$\overline{R_i} = \lambda_0 + \lambda_1\beta_{adji} + \lambda_2\ S/F_i + \lambda_3\ L/F_i + \lambda_4\ Skew_i + \lambda_5\ Exkurt_i + \varepsilon_i \quad (3)$$

Where:

$\overline{R_i}$ = Average monthly log return for stock i;

λ_0 = Regression intercept;

β_{adji} = Adjusted beta for stock i;

λ_1 = Estimated beta risk premium;

λ_2 = Estimated size premium;

S/F_i = Size factor for stock i

L/F_i = Liquidity factor for stock i;

$Skew_i$ = Skewness of returns for stock i;

$Exkurt_i$ = Excess kurtosis of returns for stock i;

λ_3 = Estimated liquidity premium;

λ_4 = Estimated skewness premium;

λ_5 = Estimated kurtosis premium;

ε_i = Random return for stock i.

If the CAPM is strictly valid, then $\lambda_0 = R_f$, $\lambda_1 = E_m$, $\lambda_2 = 0$, $\lambda_3 = 0$, $\lambda_4 = 0$, $\lambda_5 = 0$ and $\varepsilon_i = 0$.

Thus,

$$\overline{R_i} = R_f + E_m\beta_{adji}$$

Where:

$\overline{R_i}$ = Average monthly log return for stock i;

R_f = Risk-free monthly log return or the zero-beta rate of return;

β_{adji} = Adjusted beta for stock i;

E_m = Average monthly market risk premium.

However, the CAPM is partially valid if the following weak conditions are satisfied. Thus, we fail to reject the CAPM if: (i) λ_1 is positive and statistically significant, and (ii) λ_2, λ_3, λ_4, and λ_5 are simultaneously statistically insignificant.

3.4.2. Statements of hypotheses

The formal hypothesis tests are as follows:
Hypothesis test 1

H_0: $\lambda_1 \leq 0$

$$H_1: \lambda_1 > 0 \tag{4}$$

Hypothesis test 2

H_0: $\lambda_2 = 0$

$$H_1: \lambda_2 \neq 0 \tag{5}$$

Hypothesis test 3

H_0: $\lambda_3 = 0$

$$H_1: \lambda_3 \neq 0 \tag{6}$$

Hypothesis test 4

H_0: $\lambda_4 = 0$

$$H_1: \lambda_4 \neq 0 \tag{7}$$

Hypothesis test 5

H_0: $\lambda_5 = 0$

$$H_1: \lambda_5 \neq 0 \tag{8}$$

3.4.3. Decision criteria

1. CAPM is strictly valid if and only if we accept Hypotheses 2, 3, 4, and 5, and simultaneously reject Hypothesis 1. In addition, the intercept term λ_0 must be non-negative and approximately equal to the risk-free rate, and the beta slope coefficient λ_1 must equal the market risk premium
2. CAPM is partially valid if we accept Hypotheses 2, 3, 4, and 5, and simultaneously reject Hypothesis 1
3. CAPM is not valid if: (i) We reject at least one of Hypotheses 2, 3, 4, and 5, or (ii) we fail to reject Hypothesis 1.

3.5. Model Diagnostics

3.5.1. Testing for multicollinearity

Multicollinearity is a problem encountered in multiple regression modeling where one or more independent variables are linearly related. This problem results in overstated R square values and standard errors. Preliminary detection of multicollinearity uses a zero-order correlation matrix of independent variables, in which case multicollinearity is indicated if the zero-order correlation between any pair of independent variables exceeds 0.8 (Gujarati, 2004). However, a more robust way of detecting multicollinearity is to use variance inflation factors (VIFs). In this case, multicollinearity exists if there is a VIF >10 (Gujarati, 2004).

3.5.2. Testing for heteroscedasticity in residuals

An important assumption of ordinary least squares regression is that regression residuals are homoscedastic, i.e., the variance of residuals is constant. We detect heteroscedasticity using residual plots. We plot the squared regression residuals against the dependent variable, and heteroscedasticity is indicated when the squared residuals show some systematic relation to the dependent variable. In addition to the residual plots, we also employ the Park test and the Breusch–Pagan–Godfrey (BPG) test.

3.5.3. Testing for serial correlation and model misspecification

Serial correlation occurs when successive values of regression residuals are not independent, which suggests a systematic relationship between residuals. We detect serial correlation using the Durbin–Watson (DW) d statistic. We refer to the DW tables to arrive at a conclusion. However, a standard rule of thumb is that a d statistic value close to 2 rules out positive serial correlation.

3.6. Approaches to Interpretation of Regression Output

3.6.1. Overall significance of regression model

We use the F-test to determine the overall significance of the regression model developed to explain stock returns on the ZSE. The independent variables have a significant joint effect on stock returns if the calculated F-value exceeds the critical F value at the 5% level of significance.

3.6.2. Statistical significance of individual independent variables

We determine the statistical significance of individual independent variables in the model using probability values (P values), which give the minimum level of significance at which the given independent variable is statistically significant. If the fixed level of significance for the test exceeds the P value, then the independent variable is significant, otherwise it is insignificant. Thus, at a fixed significance level of 5%, a P value of 0.0355 shows that the independent variable is statistically significant. Alternatively, t-statistic values >2 indicate that the independent variable is statistically significant at 5%.

4. FINDINGS

4.1. Results of Diagnostic Tests

Diagnostic tests to detect multicollinearity, heteroscedasticity, and serial correlation show that the three are not a major concern in the multiple regressions. Based on the correlation matrix approach, the highest correlation coefficient recorded between any two independent variables is 0.32 (Table 1), which exists between size and skewness. This is way below the threshold of 0.80 (Gujarati, 2004). The absence of multicollinearity is further supported by the VIFs in Table 2, which are all far below the standard threshold of 10. Thus, multicollinearity is not a cause for concern.

Residual plots indicate that heteroscedasticity is not present in the data. Based on beta, liquidity, skewness and excess kurtosis, the Park test reports a minimum P value of 0.018 (Table 3), which however shows that heteroscedasticity could be present in the residuals. To further confirm the result, we conduct the more robust BPG test at 5%. We present the results in Table 4.

Since Θ/2 < Critical χ^2 at 5%, the BPG test concludes that heteroscedasticity is not a major concern, contrary to the Park test. The BPG test is an asymptotic test, which applies best to large samples, and a sample of 31 may not be typical of a large sample. However, in view of the fact that the Park test reports only one significant coefficient out of 4, and that the BPG is a more robust test, we conclude that heteroscedasticity is not a serious cause for concern.

The test for serial correlation based on the DW *d* statistic returns a value of about 1.8074 for the entire 12-month period. DW tables show that, for 31 observations and 5 explanatory variables, a DW *d* statistic value between 1.090 and 1.825 is inconclusive at the 5% level of significance. This means that there is insufficient evidence to suggest either negative or positive serial correlation. On this basis, we conclude that serial correlation is not a cause for concern.

Table 1: Results of the correlation test for multicollinearity

Variable	Adjusted beta	Size	Liquidity	Skew	Excess kurtosis
Adjusted beta	1.00	0.04	−0.15	0.29	0.19
Size	0.04	1.00	−0.02	0.32	0.03
Liquidity	−0.15	−0.02	1.00	−0.24	−0.11
Skew	0.29	0.32	−0.24	1.00	0.10
Excess kurtosis	0.19	0.03	−0.11	0.10	1.00

Table 2: VIFs

Variable	Adjusted beta	Size	Liquidity	Skew	Excess kurtosis
VIF	1.14	1.12	1.08	1.28	1.05

VIF: Variance inflation factors

Table 3: Results of the park test for heteroscedasticity

Statistic	Adjusted beta	Liquidity	Skew	Excess kurtosis
Coefficient	2.158	(0.138)	(0.016)	0.562
P value	0.018	0.779	0.966	0.129

Table 4: Results of the BPG test for heteroscedasticity

	Df	Θ	Θ/2	Critical χ^2
Regression	4	4.0723	2.0361	9.4877

BPG: Breusch–Pagan–Godfrey

4.2. Regression Results

Table 5 shows the results of 12 rolling regressions conducted on average monthly returns and beta, size, liquidity, skewness, and excess kurtosis (Appendix 2). The results of the regression for month 1, for example, depict the predictive power of the explanatory variables with respect to the monthly stock return for the 1st month of the test period. On the other hand, results for month 6 depict the predictive power of the explanatory variables with respect to the average monthly stock return for the first 6 months of the test period, and so on. The focus of this analysis is on showing how the nature and significance of the relationship between the explanatory variables and average monthly stock returns changes as we increase the length of the cumulative prediction period from only 1 to 12 months.

The analysis considers four important aspects. Firstly, we consider the significance and joint explanatory power of the explanatory variables. We assess these aspects based on the F-test and the R^2 respectively. Secondly, we look at the nature of the relationships between individual explanatory variables and average monthly stock returns, as depicted by the sign of respective partial regression slope coefficients. Thirdly, we assess the statistical significance of the relationships between individual explanatory variables and average monthly stock returns, as inferred from the P values. Lastly, we examine changes in the above three aspects as the length of the prediction period increases from 1 to 12 months.

Based on the F-test, we find all but one of the regression models above to be statistically significant at 5%. With reference to the R^2, the joint explanatory power of the explanatory variables in the first 6 months of the test period ranges from 8.43% in month 1 to

Table 5: Summary regression output

Months	1	2	3	4	5	6	7	8	9	10	11	12
γ_0	(0.116)	(0.009)	(0.029)	(0.021)	(0.001)	(0.040)	(0.009)	(0.001)	0.026	0.024	(0.003)	(0.019)
	0.557	0.886	0.572	0.669	0.984	0.347	0.795	0.962	0.300	0.313	0.902	0.450
β_{adj}	0.135	0.138	0.149	0.131	0.162	0.150	0.098	0.047	0.017	0.011	0.026	0.034
	0.380	0.007***	0.001***	0.002***	0.000***	0.000***	0.001***	0.049**	0.405	0.543	0.153	0.090*
S/F	(0.008)	0.000	(0.001)	(0.002)	(0.000)	(0.002)	(0.001)	(0.001)	(0.000)	0.000	0.000	0.001
	0.606	0.985	0.847	0.596	0.898	0.553	0.669	0.543	0.898	0.928	0.843	0.706
L/F	(1.929)	(5.622)	(2.692)	(3.998)	(8.769)	(6.742)	(5.834)	(2.094)	(2.791)	(3.421)	(2.439)	(1.654)
	0.873	0.146	0.405	0.194	0.003***	0.014**	0.013**	0.258	0.083*	0.027**	0.095*	0.294
Skew	0.043	(0.035)	(0.024)	(0.015)	(0.028)	(0.027)	(0.019)	(0.002)	0.001	0.000	(0.003)	(0.007)
	0.419	0.042**	0.091*	0.255	0.025**	0.021**	0.056*	0.822	0.913	0.984	0.643	0.291
E/kurtosis	(0.006)	(0.001)	(0.003)	(0.001)	0.001	0.000	0.001	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)
	0.735	0.858	0.488	0.859	0.788	0.991	0.858	0.830	0.390	0.582	0.221	0.394
R2 (%)	8.43	34.29	38.75	38.33	60.11	57.25	48.56	21.70	17.09	21.44	20.37	16.47

Estimated coefficients are reported in the first line while P values are reported in the second line. ***, **, and * signify that the corresponding coefficient is significant at the 1%, 5%, and 10% levels, respectively

60.11% in month 5. Beyond the first 6 months, the explanatory power of the model generally falls from 48.56% in month 7 to just 16.47% in month 12. The explanatory power of the regression model thus has an optimum, which is about 5 months as shown in Table 5 and Figure 1. Thus, the regression model best explains average monthly stock returns over a prediction range of about 5 months, beyond which explanatory power becomes substantially low. This is a new finding in the context of CAPM tests.

Inspection of the regression slope coefficients in Table 5 yields the following general results:

i. There is a positive relation between beta and average monthly stock returns. Thus, high beta stocks are expected to generate higher subsequent average monthly returns
ii. There is generally no relation between size and average monthly stock returns
iii. There is generally a negative relation between stock liquidity and average monthly stock returns. More actively traded stocks generally earn lower average monthly returns in subsequent periods
iv. There is generally a negative relation between skewness and average monthly stock returns. Thus, more positively skewed stocks generally earn lower average monthly returns in subsequent periods
v. There is generally a negative relation between kurtosis and average monthly stock returns. Thus, stocks with flatter past return distributions tend to earn higher average monthly returns in subsequent periods.

Tests of statistical significance on the regression slope coefficients yield the following results at the 5% level of significance:

i. Beta is statistically significant for prediction ranges between 2 and 8 months.
ii. Size is statistically insignificant for the entire prediction period.
iii. The statistical significance of liquidity and skewness is irregular but the two are significant over the optimal prediction range of 5-6 months.
iv. Kurtosis is statistically insignificant for the entire prediction period.

Tests at the 1% level of significance further indicate that only beta is statistically significant for prediction ranges between 2 and 4 months, but liquidity effects exist for the 5 months prediction range. Interestingly, evidence at the 10% significance level shows that liquidity effects exist for periods in excess of 4 months, while skewness effects vanish for periods in excess of 7 months. Thus tests that use prediction ranges of say 9 months are less likely to pick the skewness effect, while tests using 3 months may fail to detect the liquidity effect. For the usual 12 months prediction range, only beta is statistically significant, albeit at 10%. Thus, the model fails to explain average monthly stock returns at 5% significance level. Surprisingly, the model is not at all useful for explaining average returns for a 1 month prediction range, thus beta is not at all significant in explaining returns in the 1st month of the prediction period. The choice of prediction range thus should be a critical choice in the conduct of CAPM tests. It appears that a prediction range of 6 months may just be adequate to capture the effects of key anomalies identified in the literature.

Based on the empirical data, the beta risk premium tends to decrease as the prediction period increases (Figure 2). Thus, the beta risk premium is not stable over time. However, the premium is relatively stable for prediction ranges of between 2 and 6 months. This coincides with the range over which beta has the greatest explanatory power. This suggests that the explanatory power of the model is heavily dependent on the stability of the market risk premium. By extension, the explanatory power of CAPM should also be maximized when the beta risk premium is stable over the prediction period.

When the average monthly beta risk premium is stable at around 0.14% between 2 and month 6, the P value for the beta risk premium is close to zero and beta is significant at 1%. However, beyond month 6 the beta risk premium becomes unstable and beta gradually loses its explanatory power.

Figure 3 shows that the size premium is virtually zero contrary to previous findings (e.g. Banz, 1981; Fama and French, 1992; 1993; 1996).

4.3. Testing the Validity of the CAPM

The results above must be viewed in the context of the hypothesis tests outlined in Section 3. Thus, in order to decide on whether to reject the CAPM or not, we make reference to the decision

Figure 1: Model explanatory power and length of prediction range

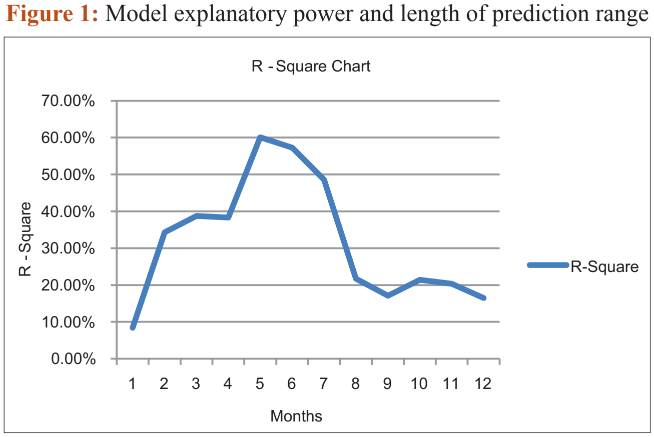


Figure 2: Beta risk premiums and significance of beta risk

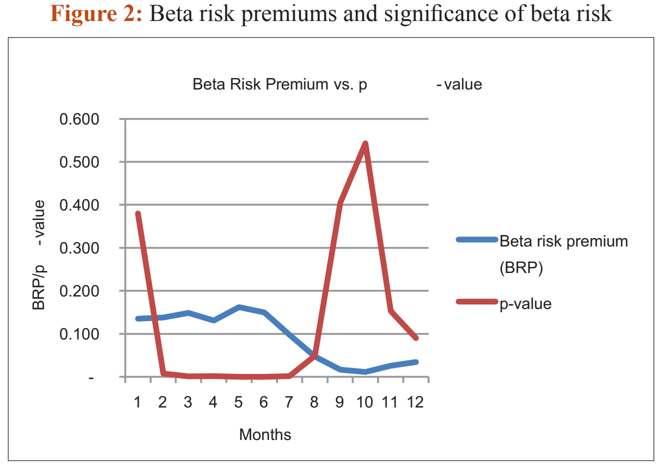
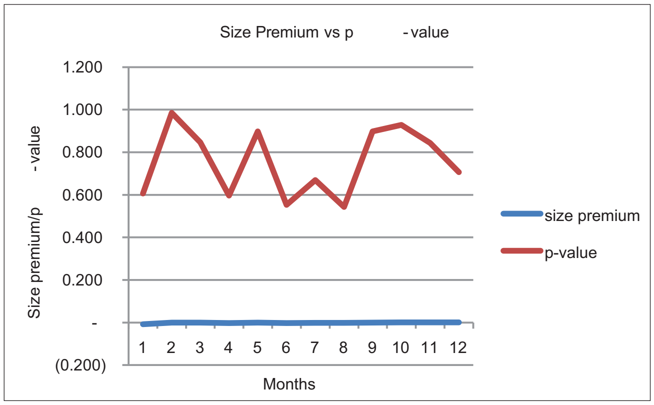


Figure 3: Size premiums and significance of the size factor



criteria. Basically, we do not reject the CAPM if and only if the beta risk premium is non-negative and beta is the only significant explanatory variable in the model of average monthly returns. We restate the results above as follows:

i. The beta risk premium is positive
ii. Beta is statistically significant at 5% for months 2 up to 8
iii. Size and kurtosis are not at all statistically significant even at 10%
iv. Liquidity, skewness are statistically significant for some prediction periods.

The findings in (i) and (ii) above lead us to reject the null hypothesis in Hypothesis Test 1 in Section 3, while findings in (iii) lead to failure to reject the null hypothesis in Hypothesis Tests 2 and 5. However, the findings in (iv) result in rejection of the null hypothesis in Hypothesis Tests 3 and 4. Since the weak conditions for the validity of the CAPM require that we fail to reject all null hypotheses in Hypothesis Tests 2, 3, 4, and 5 simultaneously, we conclude that there is evidence at 5% level of significance to suggest that the CAPM is not an adequate model for explaining average monthly stock returns on the ZSE. The study also confirms results in Conrad et al. (2013), that there is a significant negative relation between skewness and average monthly stock returns. However, there is no evidence of any size effects on the ZSE.

4.4. Discussion of Findings

While existing studies on the ZSE do not incorporate anomalies in their CAPM tests, the evidence in this study reveals that, contrary to Fama and French (1992; 1993; 1996; 2004), the size effect is non-existent on the ZSE. Beta is statistically significant, contrary to similar studies on the ZSE by Mazviona (2013) and Jecheche (2011), especially for periods between 3 and 6 months. The evidence suggests that beta provides useful insights into the pricing of risky assets, though not adequate on its own (Shiller, 2013). Although we are not able to conclude on whether the beta effect is flatter than predicted by the CAPM (Fama and French, 2004), it appears that in view of a monthly average market risk premium of about 0.14% (equivalent to an annual compounded effective rate of about 1.7%), the empirical beta effect is flatter than expected. This is consistent with Mazviona (2013) and Jecheche (2011). The intercept is virtually zero, which is clearly inconsistent with the reasonable expectation that the risk-free rate of interest should be positive. Mazviona (2013) and Jecheche (2011) also reject the CAPM partly due to the fact that the intercept is not positive.

This study reveals that, consistent with Conrad et al. (2013), there is some evidence of a significant negative relation between skewness and average return. However, the evidence contradicts Conrad et al. (2013) in that kurtosis is found to be negatively related to average returns, although the effect remains insignificant. Although not persistent, the study documents a significant negative relation between liquidity and average returns, which could potentially add to the list of so-called anomalies on the CAPM. More research however is required to concretize this anomaly.

4.5. Conclusions and Recommendations

Based on the key findings of the study and the literature reviewed, we conclude that the CAPM is not a valid description of the relationship between beta risk and return for the period from March 2009 to February 2014. However, it offers very useful insights. The beta risk-return relation is flatter than predicted by the CAPM. Beta is not the only factor that explains average monthly returns on the ZSE. There are significantly negative skewness and liquidity effects on the ZSE. The size effect does not exist on the ZSE for the period from March 2009 to February 2014. It is virtually zero. Beta is not useful for predicting returns over a 1 month horizon, and is marginally useful for predicting average monthly returns over a 1 year horizon. The latter may explain why Mazviona (2013) and Jecheche (2011) find beta to be insignificant. The predictive power of beta is a concave function of prediction horizon, and it is maximized for prediction horizons of between 5 and 6 months. Thus, studies using average monthly returns over a 1-year testing period are very likely to reject the CAPM based on poor explanatory power of beta (e.g. Mazviona, 2013; Jecheche, 2011; Fama and French, 1992; 1993; 1996). CAPM tests that use testing horizons <3 months or more than 9 months are very likely to miss liquidity and skewness effects respectively. Thus they may accept the CAPM even if it is not valid.

In view of the conclusions stated above, we recommend that analysts and investors must use the CAPM with extreme caution. Naïve application of the CAPM for any prediction horizon may yield very poor results. Investment strategies based on the size effect must be dismissed on the ZSE. Paying a premium for small firm stock in the hope that they will generate higher returns in future can only lead to investor disappointment. The size premium is non-existent. Targeting less liquid (neglected) stocks may yield some positive returns for an investment horizon of 5-7 months. However, the strategy must be applied where there is reasonable expectation that the stock will trade during that period. Holding onto neglected stock for longer than 7 months may compromise gains. Investors pursuing alpha for shorter than 6 months may find negatively skewed stocks attractive. Researchers in smaller markets must use adjusted betas with a lag adjustment for good test results. Empirical tests of the CAPM must study the performance of the CAPM on a rolling basis in order to generate further evidence on the optimal CAPM prediction range. Given that there is no better model to explain stock returns, the world might just as well make the best use of the CAPM, albeit match their applications to the empirical strengths of the model. This can only be done if tests move away from the obsession with whether the model is valid or not and instead focus on the time-bounds for useful application. Thus the world should start thinking about how to reject and still use the CAPM, with satisfactory results.

The main suggestion of this study is that research should be done to establish a standard pool of efficient proxies for the market portfolio, preferably on a continental basis. While significant methodological progress has been made on beta estimation, very little work has been done on developing efficient proxies or methods for developing the same to facilitate more useful tests of the CAPM. Scholars continue to squabble about the same old issue regarding the market portfolio but very little effort has been made in the direction of standardizing the market portfolio. The CAPM idea of the market portfolio is one that contains "all assets in the universe," yet researchers keep using localized market proxies, which often turn out to be mean-variance inefficient after all. Secondly, more cross-market CAPM tests need to be conducted to harmonize evidence on the CAPM. Most of the existing evidence is based on country cases, and hence it is very difficult to conclude that there is comprehensive evidence on the CAPM. The use of a single methodology on a cross-section of markets should generate better evidence than what is currently available.

4.6. Limitations of the Study

Roll (1977) argues that the CAPM is inherently untestable. Testing the validity of the CAPM is susceptible to many challenges. Firstly, the CAPM is an ex-ante model of returns yet only ex-post returns are available to researchers. This is an inherent weakness of the majority of CAPM tests to date and we hope that, in view of the assumption of investor rationality, realized returns are reasonable proxies for expected returns. Secondly, the market portfolio is not directly observable. Roll warned that the choice of the wrong market proxy would reduce the predictive ability of the CAPM. However, in view of the fact that key studies on the CAPM have used stock market indexes as proxies for the unobservable market portfolio, with reasonable results, the assumption that the industrial index is a good proxy for the market portfolio is reasonable. Thirdly, estimated betas for individual stocks are unstable over time. However, given that we have used adjusted betas, we expect our beta estimates to be reasonably stable. Fourthly, the determination of the strict validity of the CAPM is complicated by the fact that no reliable proxy for the risk-free asset exists in Zimbabwe, and restrictions on short sales preclude the use of the zero beta version of the CAPM. In view of this limitation, we have focused on tests of the significance of beta and the existence of anomalies. Lastly, while we have used a variety of measures to limit the effects of thin trading on the reliability of test results, some residual effect may not be ruled out. Nonetheless, given the screening criteria used in this study, the residual effect should not be significant.

5. CONCLUSION

We have tested the empirical validity of the CAPM on the ZSE and generated new insights on the model. Using cross-sectional stock returns on 31 stocks listed on the ZSE between March 2009 and February 2014, we have shown that beta is a significant factor in explaining average monthly stock returns, although the explanatory power tends to fall significantly after the first 6 months of the prediction horizon. We have failed to detect any size effects on average returns, but instead have detected some significant negative liquidity and skewness effects. In view of the criteria for testing the CAPM used in the extant literature, we reject the CAPM as an adequate model for explaining average returns on the ZSE. The primary reason is that there are significant liquidity and skewness effects over the same range that beta achieves its greatest explanatory power. We recommend that investors and analysts exercise extreme caution in applying the CAPM as it performs very poorly over horizons outside its optimal range of about 3-6 months. Furthermore, we discourage strategies based on the existence of a size premium on the ZSE. Instead, investors may consider neglected and negatively skewed stocks, albeit over appropriate horizons.

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APPENDIX

Appendix 1: Schedule of excluded stocks

Mining stocks	No data before March 3, 2009	Suspended	Stock split	Stock consolidation	Negative beta
Bindura, Falgold, Hwange, Riozim	Afdis, Border, Cafca, Chemco, Colcom, Edgars, FBCH, Fidelity, Gen Belt, Hunyani, Interfin, M&R, NTS, Nicoz, Padenga, Pelhams, Phoenix, Pioneer, Powerspeed, Radar, Seedco, Truworths, Turnall, ZBFH, Zimpapers	Celsys, Afre, PGI, RTG	Econet	NMBZ	ABCH

Appendix 2: Summary input data

Counter	Average monthly return (12 months) (%)	Adjusted beta	Size factor	Liquidity	Skew	Excess kurtosis
AFRICANSUN	5.8	1.17	(0.28)	1.18	0.51	(1.90)
ARIS	(0.8)	0.78	(0.83)	2.18	(1.90)	5.33
ART	(2.7)	0.94	(0.83)	1.78	(0.45)	(1.07)
ASTRA	(1.1)	0.52	(0.86)	0.27	0.01	(1.94)
BAT	5.1	1.19	0.11	0.24	0.73	0.44
BARC	2.1	1.42	3.19	0.43	2.06	2.93
CBZ	1.3	1.53	1.51	1.33	2.36	8.75
CFI	(2.4)	1.20	(0.56)	1.16	1.00	(0.38)
COTTCO	(17.2)	0.78	1.61	1.01	1.35	2.89
DAIR	(6.1)	0.76	0.50	1.58	0.06	(1.89)
DAWN	(2.4)	0.60	(0.20)	0.92	1.28	0.33
DELT	0.9	0.81	19.70	0.86	1.32	(0.94)
HIPP	(4.9)	1.48	4.36	0.41	2.60	5.23
INNS	(1.5)	1.04	7.87	0.67	2.75	7.76
LAFARGE	1.2	1.02	0.96	0.19	1.31	0.22
MASH	1.5	0.40	-	0.62	(2.33)	7.51
MEDTECH	(1.9)	0.42	(0.95)	0.38	(0.46)	1.28
MEIKLES	(1.2)	1.49	1.39	1.75	0.87	(2.06)
NATF	2.8	1.44	0.91	0.38	1.77	0.41
OK ZIM	(0.5)	1.03	1.39	0.76	2.33	5.42
OLDMU	2.1	0.87	2.88	1.27	1.08	(1.76)
PEARL PROP	(0.3)	0.53	(0.16)	1.19	(1.25)	2.30
PPC	0.2	0.65	0.58	0.82	(0.24)	(0.43)
STAR AFRICA	(4.3)	0.51	(0.34)	0.88	2.23	5.66
T.S.L	5.8	1.24	(0.20)	0.70	1.60	0.80
TA	(1.4)	1.06	0.36	0.57	0.53	(0.75)
W/DALE	1.5	1.51	(0.89)	0.48	1.53	3.04
ZECO	0.0	2.17	(0.95)	0.03	(1.07)	6.11
ZIMPL	(3.7)	0.49	(0.52)	0.52	1.46	1.67
ZIMRE	0.1	0.81	(0.67)	0.51	1.05	0.20
ZPI	(2.0)	0.67	(0.61)	0.67	1.10	(1.27)