ASSET PRICING MODELS: AN INVESTIGATION INTO DETERMINING THE VALUE OF JSE ALTX EXCHANGE LISTED SHARES

C. H. Dercksen

11660597

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Supervisor: Prof. I. Nel

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This dissertation is dedicated to my sister Anliso Fourie that passed away this year; your memory will be with us forever.

results are confirmed in future studies using more data.

OPSOMMING

Die stigting van die AltX beurs het die geleentheid gebied vir beleggers om te belê in klein hoë groei maatskappye wat soms uitsonderlike opbrengste lewer. Die firmas wat gelys is op die AltX beurs het uitsonderlike opbrengste gelewer oor die laaste paar jaar en in Maart 2007 was die prys verdienste verhouding 1.4 maal meer as die JSE hoof beurs se verhouding.

Beleggers wat uitsondelike opbrengste verwag sal dus hierdie aandele in hul portfolios wil insluit, maar 'n toepaslike bate prys model is nodig om aandele vir 'n portfolio te oorweeg. Vorige studies het gewys dat tradisionele bate prys modelle moeilik toegepas word op bates van hierdie aard.

Drie wyd gebruikte modelle van toenemende kompleksiteit is ge-identifiseer om getoets te word ten opsigte van die AltX beurs. Die modelle is die Kapitaal Mark Prys Model, die Fama-French Drie Faktor Model en die Arbitrage Prys Teorie.

Die voorspellings vermoë van al drie die modelle word ge-evalueer met 'n Twee Stap Regressie metode. Die eerste stap behels 'n tydreeks regresse wat gebruik word om al die faktore vir die modelle te bepaal. Die voorspellings vermoë van die modelle word dan ge-evalueer met 'n tweede reeks kruis snit regressies oor al die maatskappye.

Jaarlikse data vir die periode 2000-2007 is gebruik in die empiriese studie. Dit is 'n baie klein hoeveelheid data en beperk die toepaslikheid van die resultate wat behaal is. Geen van die drie modelle slaag al die toepaslikheids toetse om te wys dat hul voorspellings vermoë relevant is nie. Dit bleik egter uit die R^2 dat die Fama-French Drie Faktor Model en die Arbitrage Prys Model baie meer van die variasie in verwagte opbrengste beskryf as die tradisionele Kapitaal Mark Prys model. Dit word

voorgestel dat hierdie gevolgtrekkings bevestig word in toekomstige studies waar meer data beskikbaar is.

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APT	Arbitrage Pricing Theory
CAPM	Capital Asset Pricing Model
DCM	Development Capital Market
HML	High Minus Low
JSE	Johannesburg Securities Exchange
SMB	Small Minus Big
VCM	Venture Capital Market
β	Beta
B/M	Book to Market Value Ratio
R^2	Statistical measure of how well a regression line approximates real data points

CHAPTER 1: INTRODUCTION

Some background information is given to motivate the research. A problem statement is given and the research problem is broken up into sub-problems which can be separately addressed. The methodology, scope and limitations of the research is stated and finally an overview of the dissertation chapters is given.

1.1 Background

With the establishment of the AltX JSE exchange in 2002 the opportunity was created for smaller firms to get access to investment capital. This incentive should create new opportunities and foster growth in firms that previously did not have access to public funds via the JSE.

The establishment of this exchange also provided the opportunity for investors to invest in small high growth companies which sometimes provide spectacular returns. The firms listed on the AltX JSE exchange have provided exceptional returns in the South African market over the last few years. In March 2007 the price earnings ratio on the AltX exchange was 1.4 times that of the JSE main exchange (Theobald & Williams 2007:32).

The goal of all investors is to maximize return whilst minimizing risk. In general it is accepted that a higher level of risk requires a higher level of return. This is intuitive to most investors and economists.

There is one tool that allows an investor to maintain a level of expected returns while *decreasing the associated risk. That tool is a portfolio of investments* (Brigham & Erhardt 2005:163). To enable portfolio managers to compile and structure portfolios a prerequisite is the existence of a relevant asset pricing model that relates risk to the expected return of an asset.

The high growth characteristics of the companies listed on AltX should make their shares very attractive for high growth portfolios. There is however problems that prevents these shares from being readily included in portfolios.

One such a problem was highlighted in a study by Van Heerden (2004:39) namely that the CAPM and associated Beta cannot be used as a measure of market related risk for venture companies. In similar markets the constraints that led to problems were found to be low volumes and low frequency of trade as well as long periods without dividend returns (Iqbal & Brooks 2007:75).

1.2 Problem Statement

Small high growth firms provide and opportunity for investors to realize exceptional returns. These firms however are viewed as having a high degree of risk. Many investors and fund managers avoid investing in these companies because the normal risk return relationships used to value assets do not apply to these kinds of stocks. It would however be very beneficial to find suitable models for pricing these kinds of assets as the exceptional returns from these shares could make it suitable in many portfolios.

1.3 Main Goal

The main goal of this study is to compare the most well known asset pricing models as evaluation instruments for shares listed on the JSE AltX exchange.

1.4 Sub Objectives

The study can be broken down into the following sub objectives:

a) The first objective is to describe the asset pricing models commonly used by both industry and academia.
b) A second objective is to evaluate whether the higher liquidity of the new AltX exchange (compared to the older Venture Capital Market (VCM) and Development Capital Market exchanges) have made the use of CAPM and

Beta for risk return estimation viable.

c) Thirdly it is important to compare the other asset pricing models with CAPM and Beta to see if it provides better results.

1.5 Research Methodology

The research for this dissertation will start of with a theoretical overview of the three most widely used asset pricing models. Theory will also be presented on how these pricing models are used to structure an investment portfolio to show the usefulness of the models in portfolios.

Empirical research will then be undertaken to determine which of these asset pricing models provide the most relevant risk return relationship. It is important to mention the relevant risk return relationship - as a simpler model will be preferred over more complex models when the models provide comparable results.

Equities listed on the AltX exchange will be assessed using the different pricing models. This will entail determining the factors of the models and then testing these models for predictive ability.

The following models will be used in the empirical study:

- The capital asset pricing model (CAPM) a very widely used one factor model. This model is the de facto standard used for pricing assets and structuring portfolios.
- The Fama-Fench model, a three factor model. This model is gaining popularity as a much larger portion of variability is described by the model.

- Arbitrage pricing theory, a multi factor model. This model it is argued describe the variability of specific equities to a very large degree, but it can be very difficult to structure portfolios using it.

1.6 Scope of the Study

This study will focus on the equities listed on the AltX exchange.

It's important to note that this study is only dealing with the South African exchanges and no comparisons will be made with similar exchanges from other parts of the world.

Data for companies from the earlier venture capital market and development capital market might be used in this study if AltX listed company data is too limited.

The study will not be limited to any specific sector on the exchanges as the small amount of companies listed for a significant period already makes analysis difficult.

1.7 Limitations of the Study

Due to the nature of the AltX exchange there are several limitations to this study:

- Lack of information. The AltX exchange was only created in 2003 (JSE 2008) and therefore at this time only a maximum of 5 years of data is available. The problem is that most companies have not been listed for this period and the study will have to be done with less data points for many of the companies.
- Thin trading. Low volumes and infrequent trading has been shown to bias risk return predictors (Danis and Kadlec, 1994:1787). The AltX listed companies are much more thinly traded than main board listed companies and this will make the evaluation of the different asset pricing models problematic.

1.8 Layout of the Study

The dissertation will be divided up into the chapters described below and follow the sequence as presented:

Chapter 2: An Overview of Asset Pricing Models

The capital asset pricing model is derived and its use for this study is described.

The origins and form of the Fama-Fench model is described.

Arbitrage pricing theory is discussed and the model equations are given.

Chapter 3: Empirical Study

Each of the models presented in Chapter 2 is evaluated using the Two Pass Regression methodology to determine predictive abilities.

Chapter 4: Conclusion

The results of the research are assessed. Some conclusions are drawn from the research. Recommendations for future research building on the results of this study and addressing some of the limitations of this study is given.

Appendix

Detailed graphs and tables for all the empirical research is presented in the appendix.

CHAPTER 2: AN OVERVIEW OF ASSET PRICING MODELS

The three most widely used asset pricing models are described in this chapter. The capital asset pricing model, Fama-Fench model and Arbitrage Pricing Theory is discussed.

2.1 The Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model also known as CAPM is a model widely used in finance to determine the required rate of return of an asset. The CAPM formula uses the asset's sensitivity to non diversifiable risk (market risk) as well as the expected return of the market and the expected return of a theoretical risk free asset. The sensitivity of an asset to market risk is usually represented by Beta (β) in the financial industry.

The model was introduced by Jack Treynor, William Sharpe, John Lintner and Jan Mossin independently, building on the earlier work of Harry Markowitz on diversification and modern portfolio theory (Siu, 2007).

2.2 Assumptions

Various assumptions must be defined in order to arrive at the CAPM equilibrium; some of these assumptions are relevant but some are not possible in reality and cause some of the criticism that people use to substantiate the use of other more complex models.

These assumptions according to Bodie, Kane and Marcus (1999:282) are:

- Investors maximize expected utility of wealth.
- Investors have homogenous expectations and use the same input list.
- Markets are frictionless—the borrowing rate is equal to the lending rate.
- There are many investors, each with an endowment of wealth which is small compared to the total endowment of all investors (investors are price-takers).
- All investors plan for one identical holding period; and
- There are no taxes or transaction costs.

With the assumptions given one can build the CAPM model and arrive at the prevailing equilibrium. A quick overview will be given of how the model is constructed

in the next few paragraphs.

2.2.1 Model derivation

This model derivation is done in the fashion as presented by Taylor (2005). It is different from the one usually presented in text books but very easily understandable.

All investors will choose the market portfolio, also referred to as M, as the optimal portfolio. The market portfolio includes all assets in the economy, with each asset weighted in the portfolio in proportion to its weight in the economy. The assumptions say that all investors have the same expectations and the same input list. So all the investors will choose the same risky portfolio, which is located on the efficient frontier at the tangency point. That is where the line that connects the risk free portfolio with the risky portfolio is tangent to the efficient frontier. Any asset that does not form part of this portfolio would have no demand, its price would be going lower and investors seeing this will include it, driving the price for the asset up again. The consequence is that all assets will be included in the market portfolio.

Because all the information about all the assets is already incorporated in the market portfolio it would be an efficient portfolio. Each individual investor will choose to allocate investments proportionally between the market portfolio and the risk free asset, or in other words the Capital Allocation Line runs between the risk free asset and the market portfolio.

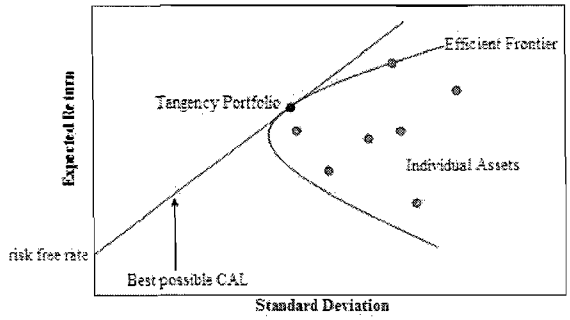

Figure 1: The Efficient Frontier (Markowitz 1999)

The risk premium on the market portfolio will be proportional to its own risk and the degree of risk aversion of the average investor. Each investor chooses a proportion b to invest in the market portfolio M and a proportion 1-b to invest in the risk free asset such that:

$$b = \frac{E(r_m) - r_{rf}}{As_m^2}$$

Where:

$E(r_m)$ is the expected return to the market portfolio;

r_{rf} is the risk free return;

A is a measure of risk aversion; and

s_m^2 is the market portfolio's risk.

Since any borrowing is offset by lending, b for the average investor is equal to 1. From this it can be shown that:

$$E(r_m) - r_{rf} = As_m^2$$

Fourth, the risk premium on individual assets $E(r_m) - r_{rf}$ will be proportional to the risk premium on the market portfolio and the Beta coefficient of the asset relative to the

market portfolio where Beta is defined as:

$$\beta = \frac{Cov(r_i, r_m)}{s_m^2}$$

Where:

Cov is the covariance between two variables;

r_m is the return to the market portfolio; and

r_i is the return of the i'th asset.

The correct risk premium of an asset must be determined by the contribution of the asset to the risk of the portfolio. As the number of assets in the market portfolio gets very large, a given asset's contribution to the risk of the portfolio depends almost entirely on its covariance with other assets in the portfolio and its weight in the portfolio, while the contribution of its own risk (or the asset's variance) to the risk of the portfolio approaches zero. Thus, as the number of assets in the portfolio gets very large:

$$Cov(r_i, r_m) = Cov(r_i, \sum w_k r_k)$$

Where:

w_k is the weight of the k'th asset.

Consequently for specific assets in the market portfolio the correct measure of risk is the covariance with the market portfolio. An asset's reward-to-risk ratio would be

$$\frac{w_i[E(r_i) - r_i]}{w_i Cov(r_i, r_m)} = \frac{E(r_i) - r_i}{Cov(r_i, r_m)}$$

Where:

w_i is the weight of the i'th asset.

Because the market is in equilibrium, all assets must offer equivalent reward-to-risk ratios, otherwise investors would choose assets with superior ratios to invest in. This means that the reward-to-risk ratio of all assets must be equal to the reward-to-risk ratio of the market portfolio, that is:

$$\frac{E(r_i) - r_{rf}}{Cov(r_i, r_m)} = \frac{E(r_m) - r_{rf}}{s_m^2}$$

or

$$E(r_i) = r_{rf} + \beta_i [E(r_m) - r_{rf}]$$

2.2.2 Form of model used in this study

The previous equation can be restated in the form usable to run a regression analysis to compute both β_i the Beta for a specific asset and β_I the Beta for an index used as a proxy for the world market portfolio (Bartholdy & Peare 2005:410):

$$r_i = \alpha_i + \beta_i r_I + \varepsilon_i$$

Where:

r_i is the return on security i on some given period;

α_i is the intercept term or equivalent to r_{rf};

β_i is the slope term;

r_I is the return on market index i for the same period; and

ε_i is the random error term.

2.2.3 Empirical studies on the validity of CAPM

To put the validity and usefulness of CAPM into perspective the main historical findings on its validity is given as well as some new studies using it specifically on emerging markets.

2.2.3.1 Historical tests for validity

The CAPM is such a widely used model that one would expect its validity to be proven beyond any doubt. The true situation is actually very different and to explain some historical background on empirical testing is given.

The first rigorous tests of the CAPM was performed by Black, Jensen and Scholes (1972:44) and the authors found that "the cross sectional plots of the mean excess returns on the portfolios against the estimated Betas indicate that the relation between mean excess return and Beta was linear". The findings of this study, and subsequent evidence by Fama and MacBeth (1973:677) and Blume and Friend (1973:19), could, be explained by the zero-Beta version of the CAPM (although the findings did not support the Treynor-Sharpe-Lintner-Mossin CAPM).

The Roll (1977:129) critique of CAPM should have been devastating to the widespread use of CAPM. Roll stated that a market index was used in previous tests of the CAPM to examine the relationship between equity returns. Roll demonstrates that the market, as defined in the theoretical CAPM, is not a single equity market, but an index of all wealth. This market must be much wider than a single index and must include bonds, property, foreign assets, human capital and anything else, tangible or intangible, that adds to the wealth of mankind. Roll also shows that unless this market portfolio is known with certainty then the CAPM never could be tested.

Several authors have tried to address the issues of the Roll critique. Shanken

(1987:91) and Kandel and Stambaugh (1987:61) both argue that the stock market is not the true market portfolio but is nevertheless highly correlated with the true market. Even with this insight they find evidence that the CAPM does not seem to hold. One can also use proxies that include broader sets of assets such as bonds and property to estimate the true market. Even when bonds and real estate are included into the market, Stambaugh (1982:237) finds that the CAPM is still rejected.

2.2.3.2 Recent Tests on Emerging Markets

Even with the above said, recent investigations have been done by several authors to test the validity of CAPM in emerging markets. Iqbal and Brooks (2006:91) investigated the Pakistan stock market, a thinly traded and volatile market. It was found that in daily data the CAPM could explain expected returns while in case of weekly and monthly data no significant explanation of returns were found.

Gonza'lez (2001:333) did a study on the Caracas stock market of Venezuela and found significant evidence to conclude that the CAPM should not be used to predict stock returns in the CSE. However evidence was found that the model is linear and significant evidence on the existence of other factors different from β (as known in the CAPM) that are important to predict returns.

In the Malaysian stock market some encouraging results were found. Allen and Cleary (1998:271) states that Beta is by no means "dead". In the study of the Malaysian market Beta appears to be an excellent proxy for volatility in all test periods.

Closer to the subject of this study, Van Heerden (2004:39) found that the CAPM and associated Beta cannot be used as a measure of market related risk for venture companies in South Africa. This was due to the fact that many of the venture companies had a very low or no rate of return and the calculation of a meaningful

Beta was impossible. The more structured new JSE AltX exchange might provide better data though.

2.2.3.3 Summary

CAPM is a model that is very intuitive to understand and therefore very widely used. It was however found in several studies of developed markets that the risk return relationship in CAPM is not valid for these markets. In most developed markets the same short comings have been seen. There is however exceptions in developed markets and this would warrant an investigation into the market that is the focus of this study.

2.3 Fama-Fench

As mentioned before it was found by several researchers including Reinganum (1981:439), Lakonishok and Shapiro (1986:115) and Fama and French (1992:427) that the relationship between β and average return does not exist for the period between 1963 and 1990. Researchers have therefore started to investigate the existence of other risk factors.

Fama and French (1992:427) have done extensive research in this area and found factors describing "value" and "size" to be the most significant factors, outside of market risk, for explaining the realized returns of publicly traded stocks.

To represent these risks, two factors were constructed:

- SMB (Small Minus Big) to address size risk; and
- HML (High Minus Low) to address value risk.

2.3.1 The SMB and HML Factors

2.3.1.1 The SMB factor

In a nutshell SMB accounts for the size premium of a stock. SMB is designed to measure the additional return investors have historically received by investing in stocks of companies with relatively small market capitalization. This additional return is often referred to as the "size premium".

The SMB monthly factor is computed as the average return for the smallest 30% of stocks minus the average return of the largest 30% of stocks in that month. A positive SMB in a month indicates that small cap stocks outperformed large cap stocks in that month. A negative SMB in a given month indicates the large caps outperformed.

As with the CAPM, when performing historical analysis, SMB factors are computed for each time period, most commonly monthly; and for predictive purposes (computing an "alpha" excess return), either the historical average of the factor or a well informed guess as to the current size premium is used (Borchert et al 2003:9).

It is interesting to note that the historical average from July 1926 to July 2002 of the annual SMB factor has been approximately 3.3%; and in a recent lecture, Ken French stated that he believes the annual SMB premium to be in the range of 1.5-2.0% today (French 2003).

2.3.1.2 The HML Factor

HML has been constructed to measure the "value premium" provided to investors for investing in companies with high book-to-market values. Book to market value is of course the value placed on the company by accountants as a ratio relative to the

value the public markets placed on the company. This ratio is commonly expressed as B/M.

The HML factor is constructed in a fashion similar to that of SMB, HML is computed as the average return for the 50% of stocks with the highest B/M ratio minus the average return of the 50% of stocks with the lowest B/M ratio each month. A positive HML in a month indicates that value stocks outperformed growth stocks in that month. A negative HML in a given month indicates the growth stocks outperformed the value stocks. (Borchert et al 2003:9).

Over the time period from 1926 to 2002, this premium for value stocks has averaged approximately 5.1% annually and now has a current value of approximately 3.5-4.0% (French 2003).

2.3.1.3 Interpretations of the Factors

The HML and SMB factors have been shown to have great predictive powers, often yielding an R^2 value around 0.95. This has caused them to draw attention and become widely used more than any theoretical explanation of the meaning of the factors.

SMB is more easily theoretically explainable. Small companies logically should be expected to be more sensitive to many risk factors as a result of the relatively undiversified nature of these companies and a reduced ability to absorb negative financial events.

The HML factor takes a bit more explaining than the SMB factor and is not so intuitive. The HML factor suggests higher risk exposure for typical "value" stocks versus "growth" stocks. If companies are in the group of high B/M, this is usually an indication that the companies' public market value has plummeted because of hard

times or doubt regarding future earnings. Since these companies have experienced some sort of difficulty, it seems plausible that these companies would be exposed to greater risk of bankruptcy or other financial troubles than their more highly valued counterparts (Borchert et al 2003).

2.3.2 Constructing the Three Factor Model

The Fama-French three factor model is constructed by combining the original market risk factor and the newly developed factors. Analogous to the CAPM, this model describes the expected return on an asset as a result of its relationship to three risk factors namely market risk, size risk, and "value" risk (Borchert et al 2003:10) and is defined as:

$$r_i = r_{rf} + \beta_i(r_m - r_{rf}) + s_i SMB + h_i HML$$

The coefficients in this model have similar interpretations to β in the CAPM above.

β_i is a measure of the exposure an asset has to market risk (although this Beta will have a different value from the Beta in a CAPM model as a result of the added factors);

s_i measures the level of exposure to size risk; and

h_i measures the level of exposure to value risk.

2.3.3 Recent Empirical Tests of the Fama-Fench Model

Many empirical studies have been performed using the extra factors from the Fama-Fench model. In the UK securities exchange Morelli (2007:257) examined the role of Beta, size and book-to-market equity as competing risk measurements in explaining the cross-sectional returns of UK securities for the period July 1980 through June

2000.

The methodology of the original Fama and French paper was adopted for this study. It was found that where data is segmented between up and down markets, a significant relationship is found between Beta and returns even in the presence of size and book-to-market equity. Size is not found to be a significant risk variable, whereas book-to-market equity is found to be priced by the market and is thus a significant determinant of security returns.

In an emerging market Allen and Cleary (1998:253) reports the results of a series of tests of factors driving returns in the Malaysian Stock Market. The study found strong evidence of a size effect which is reversed in a few periods. The other factor, the book to market anomaly is also significant in many years, with cumulative returns for the fifteen year sample period (1977-1992) suggesting significant premiums to the high book to market portfolio.

In another emerging market study, Wang and Di Orio (2007:335) explores the cross-sectional relationship between stock returns and some firm-specific characteristics in the Chinese A-share market for the period 1994 to 2002. The study results indicate that Beta lacks explanatory power even when its effect is examined alone in the regression analysis. It is found that size has the most significant effect in capturing variations in stock returns over the whole period. Moreover, while previous studies have concluded that the A-share market is driven by market rumour and individual investors' sentiment, this analysis suggests that the book-to-market ratio is also significantly priced.

2.3.4 Conclusion

It is not only the study by Fama and French that validated the use of the extra two risk factors in an asset pricing models. Several studies since then have supported the results. Even more encouraging is the fact that the extra risk factors seem to be