

# THE RELATIONSHIP BETWEEN BETA AND STOCK RETURNS IN THE JSE SECURITIES EXCHANGE IN SOUTH AFRICA

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## Abstract

The purpose of this study was to examine the relationship between stock beta and returns in the JSE Securities Exchange. If the model is applicable in its entirety or can explain the beta-stock returns relationship, it raises an important academic question, mainly, how should the South African financial market be viewed by investors and portfolio managers, given the political-social-economical classifications that South Africa finds itself in, sometimes referred to as developing, emerging or underdeveloped? The time-series data used was from Sharenet as well as from the South African Reserve Bank macro-economic time series data. The sample period consisted of 10 years of monthly time series data between January 2001 and December 2010. Regression analysis was applied using the conditional approach. When using the conditional capital asset pricing model (CAPM) and cross-sectional regression analysis, the findings strongly supported the significant relationship between stock excess returns and beta. However, the results do not provide strong evidence of a CAPM relation between risks and realized return trade-off in the South African financial markets. These results demonstrate that the South African financial markets are complex and financial tools, such as the CAPM can be used to explain complex financial phenomenon as in other developed markets, although complete reliance on the CAPM should be relied upon.

**Keywords:** South Africa, FTSE/JSE, CAPM, Portfolio Excess Return, Sharenet

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## 1. Introduction

The capital asset pricing model (CAPM) is one of the main financial modelling tools used internationally in the analysis of the risk-return trade-off of assets and is also considered a major contribution of academic research in the field of finance (Black, 1972). The CAPM is used in the field of investment management for asset selection, asset allocation decisions and general portfolio management. Many investors and users of financial markets information prefer the CAPM because of its simplicity and the fact that it is believed that the model captures the bulk of the risk-return trade-off. Given the very wide use of the model in globally and in South Africa, this study sought to investigate the applicability of the CAPM in South Africa. The study also sought to prove that if the model is applicable in South Africa, then investors and users of financial information should re-look at how the South African financial market is classified politically, economically, sometimes classified as a developing country, emerging market or undeveloped economy.

The Capital asset pricing model (CAPM) developed by Sharpe (1964) states that there is a positive relationship between the return for any asset

and the market  $\beta$ , or the systematic risk. The systematic return is the covariance of an asset's return and the market return (Black, 1972; Lintner, 1965; Sharpe, 1964). The CAPM is deeply rooted in the efficiency of the market portfolio, meaning that a positive linear relationship exists between expected returns and market  $\beta$ , and, more strongly, that there are no other variables except the market  $\beta$  that can explain the variance in asset returns (Alexander et al., 2001). This is the puzzling conclusion that has led to this study. Given the many macroeconomic variables that have been proven to determine share prices in various global financial markets (Fama, 1981; Friedman, 1988; Chen, 1991; Mukherjee and Naka, 1995; Nasseh and Strauss, 2000; Tatom, 2002 and Mpofu, 2011), how is it possible that only one variable,  $\beta$ , can account for all systematic risk?

The model states that asset prices have a linear relationship with two independent variables, the risk-free return and the volatility of the risk-free return to market return. These are given as the only determinants of the stock price. This assumption has been criticized by a number of researchers (Loderer, Sheehan and Kadlec, 1991; Pettengill et al., 1995, Fletcher, 1997, Isakov, 1999; Hodoshima et al., 2000 and Elsas et al., 2003) for failing to recognise the role of other

macroeconomic variables in determining asset prices. Asset pricing is considered efficient if it meets the following criteria: that the price of the asset reflects all current and future market information, leading to total elimination of outperforming the market or investor arbitrage behaviour. The CAPM is still one of the most used financial models in determining stock prices, and for this study it is important to look at the strength of the relationship between the risk exposure as measured by  $\beta$ , the risk free rate of return as measured by the average return from 91-day treasury bills and market return as measured by the returns from the FTSE/JSE all-share index. These variables make up the components in the CAPM and were investigated in this study to explain the relationship between asset returns and market  $\beta$  in South Africa, where researchers seem to agree that the political, economic and social conditions are not conducive to the attainment of market efficiency (Harvey 1995, Goetzmann and Jorion 1999).

Since its introduction in the early 1960s, CAPM has been one of the most challenging topics in finance. Investment decisions are almost entirely based on an appraisal done using the CAPM. The CAPM is simple to use and provides a rigorous way in which to evaluate projects and investments using numbers, which are easy to understand and justify. The model's strengths lie in its ability to link risk and return directly and to portray this relationship in a simple manner. In conditions of high risk, managers and investors are able to decide with ease the expected rate of return since the relationship between risk and return is assumed to be directly proportional, i.e., the higher the risk, the higher the expected return.

The CAPM model states that the correct measure of the riskiness of an asset is its  $\beta$  and that the risk premium per unit of riskiness is the same across all assets. Given the risk free rate and the  $\beta$  of an asset, the CAPM is used to predict the expected risk premium for an asset. The model is applied in the field of portfolio management, where investors look at portfolio selection. The main investment decision to buy or sell is made relatively easy by the CAPM, where assets are bought if the CAPM determines that their values are under-priced, and assets are sold if the CAPM determines that they are overpriced. This body of knowledge has been extensively tested in developed countries but very little has been done in South Africa due to limited time series data since, prior to 1994, the country faced severe economic sanctions and was literally closed-off to international markets. Only after 1994 did South Africa become a fully open market economy and pursued open market trade with free movement of capital and investments across international borders. Despite the lack of conclusive research findings being available in South Africa, this has not deterred investors and financial managers from applying the CAPM. This study seeks to determine the applicability of the CAPM in South Africa.

Despite the wide use of the CAPM in worldwide financial markets, can its use in developing countries, more specifically in South Africa, be justified? Can we justify using this model which focuses on one variable, systematic risk, as a measure of risk in asset return calculations? If the model is applicable in South Africa, it therefore raises another academic question, mainly, if the model is found to be applicable, can the South African financial market continue to be referred to as being in a developing country by investors and portfolio managers?

The purpose of this study was therefore to examine the relationship between  $\beta$  and returns in the JSE Securities Exchange in South Africa, given that South Africa is a developing country, and conditions of market efficiency are not perfect. More specifically, the study focused on determining whether  $\beta$  has a role to play in explaining the returns on the JSE and to examine whether the conditional relationship between  $\beta$  and returns, which has been shown to exist in developed markets, like the USA (Pettengill, Sundaram, and Mathur, 1995, holds for the JSE Securities Exchange.

The next section covers the literature review of the relationship between  $\beta$  and stock returns. The subsequent sections look at the data collection and a detailed analysis of monthly time-series data covering a period of 10 years. The last section presents the conclusions from the data analysis and the limitations of the study as well as proposals for future research on the risk-return trade-off.

## 2. Review of Related Literature

A number of early empirical studies supported the CAPM (Black, Jensen, and Scholes, 1972; Fama and MacBeth, 1973), however, later researchers have found that there are other variables impacting asset returns: the market value of equity ratio (MVE), the earnings to stock price ratio (E/P), and the book-to-market equity ratio (Banz, 1981; Basu, 1983; Lakonishok and Shapiro, 1986; Rosenberg, Reid, and Lanstein, 1985). Ross's (1976) arbitrage pricing theory (APT) also showed that  $\beta$  is not the only component that could measure the systematic risk of stock returns (Chen et al., 1986; Chen and Jordan, 1993). For example, Choi, Elyasiani and Kopecky (1992) investigated the impact of interest rates and exchange rates on stock returns and concluded that the interest rates and exchange rates did have an impact on stock prices. Unfortunately, one of the short comings of the APT, in spite of its advancement of asset pricing modelling, is that the factors to be included in asset pricing can be numerous, unspecified and can be difficult to measure. While the APT model was a welcome and more realistic model for relating risk to return, the model is complex and this has rendered it unreliable and unusable.

Another criticism of the CAPM was that earlier studies on the CAPM attempted to test for an

unconditional, systematic, and positive trade-off between average returns and  $\beta$ , but failed to take into account the fact that the relationship between realized returns and  $\beta$  is conditional on the relationship between the realized market returns and the risk-free rate. Pettengill et al. (1995) developed a model that looked at a conditional relationship between  $\beta$  and realized returns by separating periods of positive and negative market excess returns. Using US stock market data in the period 1936-1990, they found a significant positive relationship between  $\beta$  and realized returns when market excess returns are positive and a significant negative relationship between  $\beta$  and realized returns when market excess returns are negative. Furthermore, they found support for a positive risk-return relationship. The methodology used focused on causal relationships between returns and systematic risk.

The empirical evidence to date on the CAPM has been mixed. Results of many studies, particularly those of Black et al. (1972) and Fama and MacBeth (1973), support the CAPM. Fama and French (1992) found a platykurtic (flat) distribution between returns and  $\beta$ ; studies by French researchers (Hawawini et al., 1983) and Japan (Hawawini, 1991) were inconclusive. Empirical findings in Canada (Calvet and Lefoll, 1989), Belgium (Hawawini et al., 1989), Finland and Sweden (Ostermark, 1991), the UK (Corhay et al., 1987; Chan and Chui, 1996), Singapore (Wong and Tan, 1991), Hong Kong (Cheung and Wong, 1992; Ho et al., 2000a; b), Korea and Taiwan (Cheung et al., 1993) and Japan (Chan, and Hamao, 1991) suggest either no relationship or an inconsistent relationship between returns and market risk. Kim and Zumwalt (1979), Pettengill et al. (1995) and Chen (1982) also came to the same conclusion regarding the significance of systematic risk.

While the unconditional view of the CAPM has been extensively reviewed and tested, with most researchers finding very limited applicability of the model, Pettengill (1995) hypothesized that there is a positive relationship between  $\beta$  and realized return and tested this against a hypothesis that the average market risk premium is positive. This hypothesis is based on the CAPM's predictions on stocks with a higher  $\beta$ , that they often yield higher returns only when the market return is higher than the return of the riskless asset. Under conditions where the market return falls short of the riskless rate, those stocks with a higher  $\beta$  have lower returns. Pettengill et al. (1995) call this the conditional (ex-post) relation between  $\beta$  and return. Based on a modified Fama and MacBeth (1973) test, their empirical results supported the conclusion that there is indeed a positive and statistically significant relationship between  $\beta$  and realized returns. Their empirical results indicate that  $\beta$ s and returns are positively related in the US capital market. This conditional positive relationship is also observed in the UK

(Fletcher, 1997), Germany (Elsas et al., 2003), and Taiwan (Jagannathan and Wang, 1996).

Studies by Basu (1977), and more recently, by Bekaert (1995), Harvey (1995), Bekaert and Harvey (1997), Clasesens, Dasgupta and Glen (1998), Rouwenhorst (1998), Goetzmann and Jorion (1999) and Karacabey (2001) attempt to answer whether the standard CAPM can be applied to emerging capital markets in order to estimate the cost of equity capital in these markets. Since the individual emerging market has its unique market structure, institutional background, history, level of market integration, local risk-free return, etc., the answer may differ across countries. Choudhary and Choudhary (2010) studied the  $\beta$ -return relationship in the Indian equity market and found that residual risk had no effect on the expected returns of portfolios.

On the whole the empirical results regarding CAPM discussed in this section lead to mixed conclusions. Some the studies advocate multifactor models due to failure of market  $\beta$  alone to explain variation in security returns and others highlighted the methodological challenges in testing CAPM, mostly the proxies for future returns as well as proxies for risk-free assets. The present study is confined to testing the standard (unconditional) form of the CAPM on the JSE Securities Exchange. The next section looks at the materials and methods used in this study. The section also attempts to model the mathematical relationship between risk and return.

### 3. Materials and Methods

Emerging equity markets usually exhibit high-expected returns, high volatility, and low correlation with the developed countries' equity markets (Harvey 1995, Goetzmann and Jorion 1999). Given these factors, it is expected that the conditional rather than the unconditional relationship between  $\beta$  and return should exist in emerging markets since in these markets the period with a negative realized risk premium is more likely to be observed. According to Pettengill et al (1995), in order to guarantee a positive risk and return trade-off from the conditional CAPM, the distribution of the up market period (positive risk premium) and down market period (negative risk premium) should be symmetric. This symmetric distribution seems to exist in emerging markets as a result of the high volatility of the risky asset prices.

The objectives of this study were to examine whether the CAPM holds true in the JSE Securities Exchange; to examine whether a higher risk stocks yields higher expected rates of return; to examine whether the expected rate of return has a linearly relationship with the stock  $\beta$  or its systematic risk, and to examine whether the non-systemic risk affects the portfolios' returns. While the purpose of the study was to examine the relationship between stock  $\beta$  and returns in the JSE, the other academic objective was as follows: If the model is applicable in South

Africa, it therefore raises an important academic question, mainly, if the model is found to be applicable, even partly, how should the South African financial market be viewed by investors and portfolio managers, given the political-economic-social classifications that it finds itself in, sometimes referred to as developing, emerging or underdeveloped?

### 3.1. The data

The dataset used in this study consists of monthly time series of stock prices of 753 firms listed on the JSE Securities Exchange for the period 2001/01 – 2010/12. The returns on the FTSE-JSE All-Share index is used as the proxy for the returns on the market portfolio, while the 91-day treasury bill rate is used as the proxy for the risk-free return.

The monthly closing stock returns were calculated from monthly closing prices of the common stocks traded on the JSE. The returns were calculated using the following approximation:

$$R_{i,t} = \left( \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \right) \quad \text{Equation 1}$$

where  $P_{i,t}$  is the closing price of month  $t$  for asset  $i$ . In order to avoid survivorship bias, (if stocks with poor performance are dropped from calculation, it often leads to an overestimation of past returns) all stocks that were traded during the study period were included. The stocks that were listed after 2 January 2001 or delisted before 31 December 2010 were left out of the study.

The monthly FTSE/JSE index returns were calculated from monthly closing prices of the index using the approximation:

$$R_{m,t} = \left( \frac{P_{m,t} - P_{m,t-1}}{P_{m,t-1}} \right)$$

where  $P_{m,t}$  is the closing price of month  $t$  for the index.

### 3.2. Unconditional CAPM-model

The unconditional CAPM model that predicts a positive linear relation between risk and expected return of a risky asset is depicted by the following equation:

$$E\{R_i\} = R_f + \beta_i(E\{R_m\} - R_f) \quad \text{Equation 2}$$

where  $E\{R_i\}$  is the expected return of asset  $i$ ,  $E\{R_m\}$  is the expected return on the market portfolio,  $R_f$  is the return on the risk-free asset, and  $\beta_i = Cov_{i,m}/\sigma_m^2$  represents the systematic risk of asset  $i$ . In order to guarantee a positive risk-return trade-off, the expected return on the market must be greater than the risk-free return, otherwise, no one would want to hold the risky asset.

With the conditional CAPM approach, Pettengill et al. (1995) argue that the CAPM models the expected returns, yet, in empirical research, the realized returns are used as proxies for the expected

ones. Realised returns on the market portfolio often fall below the returns of the risk-free asset so that negative *ex post* risk premiums are observed in some periods. They propose an alternative methodology to estimate the relationship between betas and returns. Their model is *conditional* on whether the realised risk premium is positive or negative. When the realised risk premium is positive, there should be a positive relationship between the beta and return, while when the premium is negative, the beta and return should be negatively related since high beta stocks will be more sensitive to the negative risk premium and have a lower return than low beta stocks. The aim of this study, however, was to establish if an unconditional CAPM relationship exists between beta and stock returns. Beta was estimated by regressing realised stock returns against market returns.

The first step was to estimate a beta coefficient for each stock using their monthly returns. The beta was estimated by regressing each stock's monthly return against the market FTSE/JSE index according to equation 1. Based on the estimated betas the sample 187 stocks were divided into 10 portfolios. Each portfolio comprised 19 stocks based on their betas except portfolio no. 8, 9 & 10 which comprise of 18 stocks each. It is acknowledged that ranking into portfolios by observed beta is likely to introduce selection bias but this method has been proven in the past that yields similar results without being complicated (Elton and Gruber, 1995). Stocks with high-observed beta (in the highest group) would be more likely to have a positive measurement error in estimating beta. This might introduce a positive bias into beta for high-beta portfolios and might introduce a negative bias into an estimate of the intercept (Elton and Gruber, 1995).

The first portfolio—portfolio 1 has 19 stocks with the highest betas and the last portfolio—portfolio 20 has 18 stocks with the lowest betas. The second step was to calculate the portfolio betas using the following equation:

$$(R_{pi,t} - R_{f,t}) = \alpha_{pi} + \beta_{pi}(R_{m,t} - R_{f,t}) \quad \text{Equation 3}$$

where  $(R_{pi,t} - R_{f,t})$  is the realized excess returns of portfolio  $i$  in period  $t$ ,  $\alpha_{pi}$  is Jansen's alpha, representing the intercept of the SML,  $R_{m,t}$  is the realized return on the market portfolio in period  $t$ , and  $\beta_{pi}$  is the estimated beta of portfolio  $i$ .

## 4. Results and Discussion

The first exercise in testing the CAPM theory required that the betas of each stock had to be estimated using regression analysis. The beta estimates are shown in Table 1 below. The stocks were ordered from high to low, and then grouped into 10 portfolios in accordance with the methodology as described earlier. The range of the estimated stock betas is between the highest beta of 4.754 to the

lowest beta of -0.406. Most of the beta coefficients are statistically significant at a confidence interval of 95%.

**Table 1. Stock Beta Estimates**

PORT1	BETA (ALSH)	PORT2	BETA (ALSH)	PORT3	BETA (ALSH)	PORT4	BETA (ALSH)	PORT5	BETA (ALSH)
BONATLA	4.754	PERGRIN	1.021	SEARDEL	0.956	KAIROS	0.896	ARGENT	0.874
WOOLTRU-N	2.437	TREMATON	1.018	BELL	0.952	ALTRON	0.893	MASONITE	0.873
LONAFRIC	2.048	SAPPI	1.014	PARACON	0.948	HOWDEN	0.891	JDGROUP	0.870
ONELOGIX	1.359	SASOL	1.007	SEARDELN	0.946	FIRSTRAND	0.890	AECI	0.867
DATATEC	1.197	BARWORLD	1.002	GROUP-5	0.944	CULLINAN	0.889	SEKUNJALO	0.867
PINNACLE	1.184	PALAMIN	1.001	ANGGOLD	0.943	RMBH	0.888	MOBILE	0.866
ANGLOPLAT	1.176	SATRIX40	0.997	TRADEH	0.934	HCI	0.886	ASSORE	0.864
KING	1.147	DIGICOR	0.997	ILIAD	0.928	AWETHU	0.886	DON	0.862
IMPLATS	1.138	ZAPTRONIX	0.990	NAIL	0.925	CASHBIL	0.886	COMMAND	0.860
LONMIN	1.131	NASPERSN	0.984	AVENG	0.924	TONGAAT	0.885	NETCARE	0.860
NORTHAM	1.116	FARITEC	0.983	ADVTECH	0.921	BIDVEST	0.884	NICTUS	0.859
ANGLO	1.113	CONTROL	0.980	CADIZ	0.916	SALLIES	0.883	COMAIR	0.858
STELLA	1.108	PSG	0.972	MRHLD	0.916	ILLOVO	0.883	ASTRAL	0.856
METOREX	1.080	RICHEMONT	0.969	DAWN	0.915	SASFVN	0.883	WBHO	0.854
BASREAD	1.062	SOVFOOD	0.968	REMGRO	0.910	AMA	0.882	TIGBRANDS	0.853
BILLITON	1.061	OLDMUTUAL	0.964	GFIELDS	0.909	CMH	0.878	TRENCOR	0.853
SIMMERS	1.051	HARMONY	0.960	SUPRGRP	0.908	SANLAM	0.878	NEDCOR	0.852
BUILDMX	1.032	TRNSHEX	0.958	ABIL	0.902	REUNERT	0.876	PPC	0.849
DYNAMIC	1.028	STEINHOFF	0.956	BRAIT	0.897	OMNIA	0.875	CAPEMP	0.848
<b>BETA (ALSH)</b>	<b>1.433</b>		<b>0.986</b>		<b>0.926</b>		<b>0.885</b>		<b>0.860</b>
PORT6	BETA (ALSH)	PORT7	BETA (ALSH)	PORT8	BETA (ALSH)	PORT9	BETA (ALSH)	PORT10	BETA (ALSH)
ABSA	0.845	MRPRICE	0.818	INTRADING	0.793	BOWCALF	0.764	DELTA	0.706
NUWORLD	0.843	ASPEN	0.816	TRUWTHS	0.793	CARGO	0.763	BARWORLD	0.706
DORBYL	0.841	PICKNPAY	0.816	PREMIUM	0.792	NAIL-N	0.761	PUTPROP	0.705
HUDACO	0.840	GLENMIB	0.815	RAINBOW	0.791	OCTODEC	0.759	LABAT	0.703
SANTAM	0.839	METAIR	0.815	ASTRAKAP	0.791	CULINAN-P	0.757	KR-HALF	0.701
VALUE	0.839	UCS	0.812	RA-HOLD	0.788	THABEX	0.752	SABVEST-N	0.697
DCENTRIX	0.838	ITLTILE	0.810	BRIMST-N	0.786	SABLE	0.750	AFEP	0.693
DISTELL	0.837	PIKWIK	0.810	CAPITAL	0.784	OCEANA	0.743	REXTRU-N	0.673
EOH	0.835	RANGOLD	0.808	MONEYWEB	0.778	KR	0.743	KR-TENTH	0.662
DISCOVERY	0.835	MEDCLIN	0.807	MASSMART	0.776	GROWPNT	0.741	REX-TRUE	0.652
WOOLIES	0.835	CERAMIC	0.806	REDEFINE	0.774	CORWIL	0.727	AFOVR-N	0.644
CITYLDG	0.834	KGMEDIA	0.805	BEIGE	0.772	DLP1	0.727	AF-OVR6PP	0.620
ALTECH	0.831	LIB-HOLD	0.805	MT-EGLE	0.767	KR-QUARTE	0.717	SABVEST	0.606
JASCO	0.830	COMP CLEAR	0.804	EXCELL	0.767	MERCANTIL	0.716	INDEQTY	0.588
A-V-I	0.822	SPURCORP	0.804	SYCOM	0.767	DLVP	0.716	VILLAGE	0.552
INVICTA	0.821	WINHOLD	0.801	TRNPACO	0.766	SPANJRD	0.714	ARHP	0.005
NAMPAK	0.821	LONFIN	0.801	HYPROP	0.765	MUSTEK	0.709	DECILLION	-0.376
CROOKES	0.820	AFROX	0.800	BRIMSTON	0.765	SQONE	0.707	AME	-0.406
SHOPRIT	0.818	ADCORP	0.796						
<b>BETA (ALSH)</b>	<b>0.833</b>		<b>0.808</b>		<b>0.779</b>		<b>0.737</b>		<b>0.507</b>

The second step was to calculate the portfolios' betas using equation 3 as given earlier:

$$(R_{pi,t} - R_{f,t}) = \alpha_{pi} + \beta_{pi}(R_{m,t} - R_{f,t})$$

**Table 2. Portfolio returns and beta coefficients**

	91-DTBILL	JSE-ALSH	PORT1	PORT2	PORT3	PORT4	PORT5	PORT6	PORT7	PORT8	PORT9	PORT10
Excess Return	0.087	-0.08	0.03	-0.08	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.07	-0.02
Std dev.	0.019	0.11	0.69	0.12	0.13	0.11	0.11	0.10	0.10	0.10	0.12	0.40
Beta			1.433	0.986	0.926	0.885	0.860	0.833	0.808	0.779	0.737	0.507
R <sup>2</sup>			0.053	<b>0.872</b>	0.613	<b>0.750</b>	<b>0.761</b>	<b>0.789</b>	<b>0.788</b>	<b>0.726</b>	0.423	0.019

This article argues that, in accordance with the conditional CAPM theory, higher risk (beta) should be associated with a higher level of return. However, the results of the study do not demonstrate support for this hypothesis. These are shown in Table 2. The beta coefficients of the 10 portfolios do not indicate that higher beta portfolios are related with higher returns. With the exception of Portfolio 1, for example, which has the highest portfolio beta of 1.433 and yields a positive portfolio return of 0.03, all the other portfolios yield negative returns. This relationship

however is insignificant due to the high standard deviation of 0.69 compared to the other standard deviations of 0.10. Portfolio 10, with the lowest portfolio beta of 0.507 produces the smallest negative return of -0.02 and a standard deviation of 0.40.

Before the CAPM model could be used to predict the relation between beta and excess returns on the FTSE-JSE, some tests on the model had to be done. In this study the yield on the 91-day treasury bills rate was used as an approximation of the risk-free rate ( $R_f$ ). For the return on the market portfolio

$(R_m)$ , the FTSE-JSE All Share index was used as a proxy.

**Table 3.** Regression model summary

R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate		F	Sig. F	Durbin-Watson	
0.999 <sup>a</sup>	0.997	0.997	0.00204		2808.7	0.000	3.225	
a. Predictors: (Constant), Beta b. Dependent Variable: ExcessReturn								
Model	Unstandardized Coefficients			t	Sig.	95.0% Confidence Interval for B		
	B	Std. Error				Lower Bound	Upper Bound	
1	(Constant)	-0.086	.001	-104.674	.000	-0.088	-.084	
	Beta	1.016	.019	52.997	.000	.972	1.060	

The relationship between the estimated returns and beta was tested using linear regression. The model developed as shown In Table 3 was analysed to test for goodness of fit by analysing the regression coefficients, R<sup>2</sup>, standard error of the estimate, analysis-of-variance table, and residuals. The R<sup>2</sup> of 99.7% indicates that the model is a good predictor of the dependent variable. It implies that the model can be used for estimating portfolio excess returns for given beta estimates. The standard error of the estimate has a value of 0.00204, implying that there is only a two per cent error in estimating excess returns. The standard error of the estimate is a measure of the accuracy of predictions made with a regression model (bionicturtledotcom, 1998). The Durbin-Watson statistic has a value of 3.225, and, given that the Durbin-Watson statistics has a range from 0 to 4 with a midpoint of 2, the value obtained here confirms that the model is good. Finally, the F value of 2808.7 is large and has a significance value that is very close to zero. The sig. F in Table 3 is the probability that the null hypothesis for the model is true and would imply that the regression equation does have some validity in fitting the data.

The constant or intercept was a negative -0.086. According to the CAPM theory, the intercept was expected to be at least positive and close to or equal to the return on the risk-free asset (91-day treasury bill), or, in accordance with the modified CAPM model, the intercept was expected to be equal to zero. Based on the figures from Table 3, the equation for estimating excess returns (Equation 3) then becomes:

$$(R_{pi,t} - R_{f,t}) = \alpha_{pi} + \beta_{pi}(R_{m,t} - R_{f,t})$$

or

$$(R_{pi,t} - R_{f,t}) = 1.016(R_{m,t} - R_{f,t}) - 0.086$$

Before a conclusion could be reached as to whether the model developed does explain excess returns as espoused by the CAPM, two tests were run to test SML intercept as well as the SML slope. The first test was to look at the intercept. Since the CAPM assumes that the intercept on the Security Market Line (SML) should be equal to zero and the slope should equal the excess returns on the market portfolio, a test of this assumption was made.

The basic equation used was  $(R_{i,t} - R_{f,t}) = \alpha_{pi} + \beta_{pi}(R_{m,t} - R_{f,t})$  (Equation 3)

where  $\alpha_{pi}$  is the expected excess return on a zero beta asset and  $\beta_{pi}$  is the market price of risk, which is the difference between the expected rate of return on the market and a zero beta portfolio. Since the CAPM assumes a zero intercept on the SML, one way of testing for this assumption would be to force the SML intercept. This would test whether the CAPM does hold true in the estimation of the SML. One way for allowing for the possibility that the CAPM does not hold true is to force an intercept during the SML regression procedure. Since the CAPM considers that the intercept is zero for every asset, such a test can be constructed to examine this hypothesis. The results of the regression show that the slope of the SML is now 0.0332 and an R<sup>2</sup> of 16.5%. This is a very low R<sup>2</sup> and renders the model unreliable. This is also confirmed by the original SML model that shows that the intercept of -0.086 has a t-value of -104, and is significantly different from zero.

The secondly test was to examine the SML slope. According to the CAPM theory, the SML slope should equal the excess return on the market portfolio. The excess return on the market portfolio was found to be a negative -0.08 while the slope of the SML is 1.016. The latter result indicates that there is no evidence to support the CAPM. Not only is the intercept significantly different from zero, the slope of the intercept shows that the excess returns of the market portfolio at 1.016 will always be more than the average excess returns of a negative -0.08.

## 5. Conclusion

The article examined the validity of the CAPM for the JSE Securities Exchange. The study used monthly stock returns from 187 selected companies listed on the JSE Securities Exchange from January 2001 to December 2010. The findings of the article are not supportive of the theory's basic hypothesis that higher risk (beta) is associated with a higher level of return. In order to diversify away most of the firm-specific part of returns thereby enhancing the precision of the beta estimates, the securities were combined into portfolios to mitigate the statistical problems that arise from measurement errors in individual beta estimates. The model also does explain excess returns and lends

support to the linear structure of the CAPM equation being a good explanation of security returns.

The high value of the regression coefficient ( $R^2$ ) indicates that the model is a good predictor of the dependent variable. This was further strengthened by a very high Durbin-Watson statistic and a very high F value. This confirms the null hypothesis that the model is true and implies that the regression equation (SML) does have some validity in explaining excess returns.

However, the fact that the intercept has a value significantly less than zero weakens the above explanation. The high values of the SML intercept and the slope indicate that the model does not meet all the assumptions of the CAPM. The CAPM's prediction for the intercept is that it should be equal to zero and the slope should equal the excess returns on the market portfolio.

The results of the tests conducted on data from the JSE Securities exchange for the period 2001 to 2010 do not appear to clearly reject the applicability of the CAPM in explaining returns. What seems to provide a very strong conclusion is that the model does explain excess returns. This does not mean that the data do not support CAPM. It must be borne in mind that Black (1972) does explain that the failure to prove the CAPM model can be as a result of measurement and model specification errors as well as the use of proxy variables and proxy data instead of the actual market data. This error creates a bias in the regression model by moving the estimated slope towards zero and the estimated intercept away from zero. Black also states that if there is no risk-free asset, it will be impossible for the CAPM to predict the intercept of zero. The tests may provide evidence against the CAPM but that does not necessarily mean that the CAPM does not explain security returns or that it cannot be used to predict future asset returns given their level of risk.

The findings drawn from the results do not fully support the conditional CAPM despite the strong evidence of a relationship between risk and excess return. The results however do not confirm the earlier research questions: Can investors in South Africa justify using the CAPM model which focuses on one variable, systematic risk, as a measure of risk in asset return calculations? The results of the study do not support the applicability of this model in South Africa for determining a risk-return trade-off. It re-enforces the notion that  $\beta$  is a useful measure of past price fluctuations of common stocks and should not be used as a proxy for risk in a risk-return trade-off as espoused by the CAPM.  $\beta$  measures price variability but there is no evidence to suggest that it measures risk.

The second research question was, if the model is applicable in South Africa, it therefore raises another academic question, mainly, can the South African financial market continue to be referred to as being in a developing country by investors and

portfolio managers? The answer to this question is not obvious, but it can be inferred from the findings that the CAPM, one of the major financial models in use in developed countries is also not easily applicable in South Africa. The modified CAPM model that used excess returns showed that the model did show that it can explain the excess return- $\beta$  trade off. In other words, despite the rejection of the first hypothesis, the second hypothesis in neither accepted nor approved. However, it is quite evident that the JSE Securities exchange does reflect a number of exposures to risk, like any other financial market, especially international risk exposure. Perhaps, the modified International Capital Asset Pricing Model should be investigated and tested for its applicability in the JSE Securities Exchange. It can therefore be concluded that investors looking at portfolio decision on the JSE cannot comfortably rely on the CAPM, just as much as investors in developed countries cannot rely on the model.

The present study has some limitations. Firstly, the JSE is a relatively small exchange and yet highly concentrated, that is, a few large firms (about 2%) contribute almost 80% of the JSE market capitalization. Secondly, this study covered a period during which a critical event in financial markets occurred. This event came about as a result of the mortgage sub-prime market crash in the United States in 2007-2008, that eventually led to a global liquidity crisis. This liquidity crisis introduced exogenous risk factors that were not factored into the risk-return trade off during the analysis. Brunnermeier (2009) has characterized this crisis as having affected more people, companies and economies and certainly the severest since the Great Depression. Significant symptoms of the crisis include significant markets decline, liquidity dry-ups, bank failures, very high defaults by borrowers and inter-country and regional bailouts, mostly in developed countries. Brunnermeier has estimated that about \$8 trillion of the U.S. stock market wealth was lost between October 2007 and October 2008. For this reason, the financial market turmoil in 2007-08 presents a need to test theoretical predictions on how investors trade when market liquidity dries up. Further studies should factor this risk into the risk-return analysis of the CAPM.

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