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### Using Accounting Data as a Measure of Systematic Risk

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## Using Accounting Data as a Measure of Systematic Risk

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### **Abstract**

This paper proposes the use of accounting-based measures of systematic risk as an alternative to the market beta. The study used data from a sample of forty-seven Johannesburg Stock Exchange (JSE) listed companies that had consistent financial statement and market return data for the period January 1990 to December 2009. Preliminary results suggest the existence of a statistically significant relationship between measures of earnings variability and size and systematic risk. The results also indicate that the accounting variables provide better forecasts of systematic risk.

**Key words:** market beta, accounting beta, systematic risk

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## **1. INTRODUCTION**

Conventionally, systematic risk is estimated by regressing the returns of a security against the returns on a market index, with the slope of the regression (*beta*) being the measure of systematic risk. However, problems with this approach have been noted including measurement issues, such as the choice of the appropriate market index (Roll, 1977: 130), and difficulties in assessing the riskiness of unlisted and thinly traded firms, firms whose market data is either not available, or unreliable (Retief, 1984: 6; Berkowitz, 1998: 171). In addition, in South Africa a further consideration is the problem of market segmentation documented by Van Rensburg (2002) and Van Rensburg and Slaney (1997) which raises questions about the suitability of using the JSE All Share Index as the proxy for the market proxy. As a result of these challenges, an alternative approach to estimating systematic risk which does not rely on market data potentially offers substantial theoretical and practical benefits.

This paper seeks to develop a model for estimating systematic risk using accounting data. We employ a step-wise linear regression methodology to identify relevant accounting variables. We then test the resulting model's ability to explain systematic risk as measured by the market beta as well as the ability of our model to forecast systematic risk compared to a naïve market model approach using market beta. We find evidence that a statistically significant relationship exists between accounting data and systematic risk and that the accounting model developed exhibits superior ability to forecast future systematic risk.

The remainder of this paper is organised as follows. Section 2 reviews the empirical literature pertaining to the relationship between accounting data and systematic risk. Section 4 describes the data and methodology employed in the study while section 5 discusses our empirical findings. Section 6 concludes the paper with a brief summary of the results and a discussion of areas for further research.

## **2. LITERATURE REVIEW**

### **2.1 International Studies**

The earliest research on the topic of accounting measures of systematic risk was carried out by Ball and Brown (1969) and Beaver, Kettler and Scholes (1970). Ball and Brown (1969)

found that an accounting beta based on operating income was most closely associated with the market beta. Beaver *et al.* (1970) developed an estimate of systematic risk using payout, growth and earnings variability and concluded that the accounting variables provided superior forecasts of systematic risk compared to a naïve forecasting model. Petit and Westerfield (1972) found a significant relationship between the market beta and cash flow and capitalisation rate betas while a strong negative relationship was observed between the dividend payout rate and the market beta. Gonedes (1973) found a statistically significant relationship between market beta and accounting estimates of systematic risk if the accounting betas were based on first differences in income numbers. Beaver and Manegold (1975) also found a significant relationship between accounting betas and the market beta but observed that the accounting betas' explanatory power was low.

Castagna and Matolscy (1978) found that debt to equity, debt to total assets, EBIT to total assets, return on equity (ROE), growth in EPS, liquidity ratio, current ratio, dividend payout and interest coverage were all significantly related with systematic risk. Hill and Stone (1980) identified changes in financial leverage and operating risk (measured by changes in the operating beta) as having significant value in explaining changes in market beta. Similarly, Mandelker and Rhee (1984) found a positive relationship between a firm's degree of operating leverage (DOL) and degree of financial leverage (DFL). Chun and Ramasamy (1989) examined the relationship between accounting variables and market risk in Malaysia and found evidence of a negative relationship between liquidity (current ratio), profitability (ROE) and activity (net income to turnover). Ismail and Kim (1989), on the other hand, focussed their study on earnings measures and found that an earnings measure, two funds flow measures and a cash flow measure were all significant factors in explaining the market beta as well as evidence that the cash flow beta was superior to both the funds flow and earnings betas.

Mensah (1992) revisited the Mandelker and Rhee (1984) study and proposed the inclusion of an accounting beta to measure intrinsic business risk (IBR) which he argued reflected the cyclicity of a firm's accounting flows relative to other firms. In addition Mensah (1992) also included the four accounting flows used by Ismail and Kim (1989) and found that funds flow from operations had the greatest explanatory power and that IBR and DOL were consistently significant in all four accounting flow models. Berkowitz (1998) estimated systematic risk using financial leverage, earnings variability, asset growth and earnings beta.

Financial leverage and asset growth were found to be significant factors in explaining variation in the market beta across 144 Canadian firms but earnings variability and earnings beta were not.

More recently Brimble (2003) found that operating leverage and firm size were significant factors in explaining systematic risk for Australian firms. Earnings variance, earnings sign and liquidity were significant for some industries and not for others indicating that the risk relevance of accounting data may vary across industries. Brimble (2003) also found that accounting risk models outperform other forecasting models. Portella and da Rocha (2006) also investigated the risk relevance of accounting data in a developing economy by studying the relationship between market beta and accounting variables for listed firms in Brazil. They found that variables related to operating risk (namely return on net operating assets, profit margin, asset turnover, and change in net operating assets) to be significant in explaining systematic risk.

## 2.2 South African Studies

Retief (1984) pioneered the study of the use of accounting data to measure systematic risk in South Africa. He analysed 63 June year-end firms listed on the Johannesburg Stock Exchange (JSE) between 1973 and 1982 using a stepwise linear regression approach. Retief (1984) found evidence to suggest that financial leverage, cash flow standard deviation, cash flow beta and the current ratio were relevant accounting variables at the firm level. When, however, he divided the firms into portfolios comprising of three shares each only financial leverage, cash flow beta and the current ratio were found to be relevant and only financial leverage was found to be relevant in the case of portfolios of six shares.

Wessels, Smith and Gevers (1993) followed the approach of Ismail and Kim (1989) by investigating the relationship between cash flow variables and the market risk of 53 JSE listed industrial firms between 1873 and 1987. Their results, however, found that none of the accounting betas was statistically significant in explaining market risk. Loxton, Hamman and Smit (1994) extended the Wessels *et al.* study by examining the effect of research design considerations on the relationship between market beta and earnings and cash flow betas. They concluded that the measurement period had a significant impact on the significance of the relationship between accounting variables and the market beta and, in contrast to Ismail

and Kim (1989), that the relationship with market beta was stronger for the earnings and fund flow betas than for cash flow betas.

Bergesen and Ward (1996) measured the association between the market beta and several accounting variables for a sample of 135 JSE listed industrial shares for the period 1878-1993. Their result suggested that the market beta was positively related to measures of firm growth and profitability and negatively related to dividend yield and measures of “short-term managerial performance” such as liquidity and stock turnover. The forecasting ability of their risk models, however, was poor.

From the above review, it is apparent that a surprising lack of consensus is evident in the research findings with a wide range of accounting variables, incorporating all of the major categories of ratio analysis, being found to be linked to systematic risk. There is also evidence that the relevance of accounting variables in explaining systematic risk may differ between industries and between markets. It is also evident that the limited research on this topic in South Africa is extremely dated and does not capture the systemic changes which have followed in South Africa’s reintegration into the global economy following the end of Apartheid. This study seeks to address this problem by conducting a fresh study of the relationship between accounting variables and systematic risk.

### **3. METHODOLOGY**

#### **3.1 Data and Sample Selection**

In order to address the research problem highlighted above, financial statement and share price data was obtained for the period January 1990 to December 2009. The data required was obtained from McGregor Bureau of Financial Analysis (BFA) Library and was only available from 1990. The 20-year period was thus chosen due to data availability and the need to keep the data relevant to reflect the systematic risk factors relevant for South African firms post reintegration into the global economy. Out of the 328 companies listed on the JSE Main Board, only 47 met the following selection criteria:

- had available accounting and market data from January 1990 to December 2009;
- had a consistent financial year-end during the study period;
- were non-banks and insurance companies; and
- had rand denominated financial statements.

Following Beaver *et al.* (1970: 670) and Mandelker and Rhee (1984: 52) the sample was divided into portfolios of 3 and 6 shares by ranking the companies on historical beta in order to mitigate the impact of measurement error on the estimated relationship between accounting variables and beta. The regression analysis was then conducted at the level of the individual firms, 3-share portfolios and 6-share portfolios.

### 3.2 Model Specification

The dependent variable in the analysis was market beta estimated for each company using the market model of Sharpe (1964). The dependent variables comprised a series of accounting measures calculated for each firm. The study made a conscious effort to avoid the practice in many previous studies of selecting accounting variables for inclusion based on intuition by selecting variables based on the following criteria (Bildersee, 1975: 83; Retief, 1984: 159):

- variables that are frequently mentioned in literature;
- variables that have successfully been used in prior studies; and
- variables that are associated with each general class of accounting ratios.

Applying the above criteria, the following accounting variables were selected: accounting beta, earnings variability, cash flow standard deviation, financial and operating leverage, dividend payout ratio, firm size, growth in assets, and liquidity. Although some of these variables are not conventional accounting ratios, they are drawn from the general classes of accounting ratios. Table 3.1 below presents the definition used for each accounting variable.

Accounting beta, earnings variability, cash flow standard deviation, growth, financial leverage and operating leverage are expected to be positively related to systematic risk, while dividend payout, size and liquidity are expected to be negatively so.

The accounting variables model should ideally consist of only those accounting variables that are statistically significantly related to market beta. In order to ensure that only relevant variables were included in the final specification of the accounting variables model, a stepwise regression model was used to eliminate any irrelevant accounting variables. To identify relevant variables a p-value of 0.1 (equivalent to a 10% level of significance) was chosen as the criterion as it strikes a balance between the probability of including irrelevant variables (type I error) and that of excluding relevant variables (type II error). Variables that met this criterion were included in the final regression model.

**Table 3.1: Definition of Accounting Variables**

Variable	Measurement
Earnings variability	$\sqrt{\frac{\sum_{t=1}^n (E_t - \bar{E})^2}{n-1}}$
Liquidity	Current Assets/Current Liabilities
Cash flow standard deviation	$\sqrt{\frac{\sum_{t=1}^n (CF_t - \bar{CF})^2}{n-1}}$
Dividend payout	Dividend paid/Earnings available to ordinary shareholders
Operating leverage	<ul style="list-style-type: none"> <li>• Percentage change in EBIT/Percentage change in turnover</li> <li>• EBIT/Turnover</li> </ul>
Financial leverage	<ul style="list-style-type: none"> <li>• Total Liabilities/Total Owners Interest</li> <li>• (Total Assets – Total Owners Interest)/Total Assets</li> </ul>
Accounting beta	$\frac{Cov(ROE_t, RCE_{M,t})}{Var(RCE_{M,t})}$
Growth	$\ln\left(\frac{Total\ Assets_t}{Total\ Assets_{t-1}}\right)$
Asset size	$\ln(Total\ assets)$

### 3.3 Predictive Ability

In order to test the practical usefulness of accounting variables in predicting systematic risk the accounting variables model developed by means of the stepwise regression was compared to a naïve forecasting model. The naïve forecasting model assumes that that the current beta is a sufficient indicator of the future beta and it has been argued that it demonstrates superior performance in predicting systematic risk (Beaver *et al*, 1970; Eskew, 1979). The naïve forecast model and the accounting variables model are given by:

$$\beta_{it+1} = \alpha + \gamma\beta_{it} + \mu_t \quad (2)$$

$$\beta_{it+1} = \alpha + \gamma\sum_{i=1}^n b_i X_i + \mu_t \quad (3)$$

where:  $\beta_{it+1}$  is the market beta estimated for the 2005 to 2009 period,

$\gamma$  is a regression coefficient; and,

$b_i$  and  $X_i$  are the regression coefficients and accounting variables from equation 3.

The full 20 year period was thus divided into an in-sample period extending from 1990-2004 which was used to develop the accounting variables model and the remaining five year period was then used for the out-of-sample forecast evaluation. The root mean squared error (RMSE), the mean absolute error (MAE), and Theil's U-statistic were then calculated for each model to compare their relative forecasting ability.

#### 4. FINDINGS

##### 4.1 Multivariate regression model

As a first step the correlation between the possible variables under consideration was examined. An analysis of the correlation matrix in Table 4.1 reveals that some variables were highly correlated.

**Table 4.1: Correlation Matrix**

	acc beta	beta	cf std	cr	de	dpr	dta	ebitt ovr	eps var	evar	growth	op lev	size
accbeta	1.00												
beta	0.52	1.00											
cfstd	0.96	0.48	1.00										
cr	-0.08	-0.35	-0.07	1.00									
de	0.10	0.06	0.09	-0.33	1.00								
dpr	-0.17	-0.06	-0.17	-0.22	-0.06	1.00							
dta	0.14	0.07	0.11	-0.36	0.89	-0.12	1.00						
ebittovr	0.25	-0.02	0.20	-0.03	-0.19	0.11	-0.18	1.00					
epsvar	0.35	0.46	0.33	-0.07	-0.09	-0.03	-0.09	0.08	1.00				
evar	0.97	0.52	0.99	-0.07	0.09	-0.19	0.11	0.22	0.42	1.00			
growth	-0.03	0.21	-0.01	-0.14	0.22	-0.16	0.21	-0.01	0.07	-0.01	1.00		
oplev	0.10	0.02	0.06	0.16	0.10	-0.08	0.11	0.06	0.11	0.08	-0.12	1.00	
size	0.03	0.43	0.01	-0.31	-0.02	0.28	0.12	-0.08	0.25	0.02	0.07	-0.03	1.00

The most notable correlations were between: the accounting beta and earnings variability and cash flow standard deviation; earnings variability and cash flow standard deviation; and the two leverage variables. These variables are highly correlated as they are calculated using largely similar data and represent the same classes of accounting ratios. In order to avoid multicollinearity, preliminary tests were conducted to establish the most significant of the correlated variables. The accounting variables that exhibited a high degree of correlation were included in separate regressions and the variable that appeared more statistically

significant (based on the  $R^2$  and information criteria<sup>1</sup>) was selected for inclusion in the multivariate regression model. The same process was applied to select between ratios falling within the same ratio class.

The multi-factor model arrived at through this process was as follows.

$$\beta_i = a_0 + a_1\text{OPLEV}_i + a_2\text{DPR}_i + a_3\text{CR}_i + a_4\text{EVAR}_i + a_5\text{DE}_i + a_6\text{SIZE}_i + a_7\text{AG}_i + e_i \quad (1)$$

where:  $a_0$  is the intercept term;

OPLEV is the operating leverage ratio;

DPR is the dividend payout ratio;

CR is the current ratio;

EVAR is the earnings variability;

DE is the financial leverage ratio;

SIZE is the asset size variable;

AG is the growth in assets; and,

$e_i$  is the error term.

The results of the multivariate regression model comprising all selected accounting variables (after eliminating the correlated variables) are presented in Table 4.2.

**Table 4.2: Cross-Sectional Regression Model Results (All Accounting Variables)**

Variable	1990-2004			1990-2009		
	Shares in Portfolio			Shares in Portfolio		
	1	3	6	1	3	6
<b>a</b>	-0.629	-3.248***	-4.307	-0.412	-1.428*	-1.791
<b>CR</b>	-0.008	0.485***	0.736	-0.191**	-0.353***	-0.241
<b>CFSTD</b>	0.130*	0.337***	1.024			
<b>EVAR</b>				0.477***	1.024***	
<b>EPSVAR</b>						0.113**
<b>DTA</b>	0.077	-0.860*	-1.461	-0.531	-0.855*	0.563
<b>DPR</b>	0.157	-0.424*	-0.812	-0.225	-0.509	-1.697
<b>EBITTOVR</b>	-0.374*	0.019		-0.265	-0.739***	
<b>GROWTH</b>	0.655	4.958***	4.757	1.177	1.739*	1.278
<b>SIZE</b>	0.082***	0.215***	0.291	0.098***	0.203***	0.201*
<b>Adj. R<sup>2</sup></b>	0.323	0.919	0.856	0.474	0.927	0.994

\* Statistically significant at the 10% level

\*\* Statistically significant at the 5% level

\*\*\* Statistically significant at the 1% level

<sup>1</sup> The Aikaike, Schwarz-Bayesian and Hannan-Quinn information criteria were used. Where conflicting results were obtained the Schwarz-Bayesian criteria was preferred.

The results show that the proportion of systematic risk explained by the accounting variables ranges from 32 to 92 percent for the 1990 to 2004 period, and 47 to 99 percent for the 1990 to 2009 period. The results show a significant improvement in the proportion of systematic risk explained by the accounting variables as the number of shares in a portfolio increases. However, the results also show that not all accounting variables are statistically significant. Based on the *a priori* expectations, some of the variables have the wrong signs in some periods and at different shareholdings. For instance, the current ratio is positive in the case of the 3 and 6-share portfolios during the 1990 to 2004 sub-period, while the financial leverage ratio was negative and statistically significant at the 10 percent level for the 3-share portfolios in both periods.

Also contrary to expectations was the consistently positive and statistically significant relationship between firm size and systematic risk. However, the positive relationship between size and systematic risk observed in this study is not entirely new as the same observation was made by Bergesen and Ward (1996) in the South African context and Castagna and Matolcsy (1978) and Brimble (2003) in studies of Australian companies. Castagna and Matolcsy (1978: 117) argued that the observed positive relationship between size and systematic risk could be a result of two main factors: the fact that what are referred to as small firms in such small markets as Australia and South Africa are in fact big firms and that larger companies in smaller markets generally engage in riskier activities compared to smaller firms. These results presented in this study supports previous research suggesting that contrary to the negative relationship between beta and size reported in a number of U.S. studies (see for example Eskew, 1979; Bowman and Bush, 2006), a positive relationship exists in smaller and developing markets such as South Africa and Australia.

Some of the accounting variables showed signs contrary to theoretical expectations which could be a result of the presence of correlated variables in the regression model. In order to eliminate the less significant of the correlated variables, stepwise regression analysis was used, the results of which model are presented in Table 4.3. The results indicate that firm size, cash flow and earnings variability are consistently statistically significant at both the individual share and portfolio levels. The cash flow and earnings variability have the expected sign, while size maintains the “wrong” sign first observed in Table 4.2. The hypothesised relationship between systematic risk and the current ratio, EBIT to turnover, and growth is also observed, though not consistently.

**Table 4.3: Summary of Stepwise Regression Results**

Variable	1990-2004			1990-2009		
	Shares in Portfolio			Shares in Portfolio		
	1	3	6	1	3	6
<b>a</b>	-0.601*	-1.830***	-2.906***	-0.695	-2.211***	-3.167***
<b>CR</b>				-0.145*	-0.272***	
<b>EBITTOVR</b>	-0.389*					
<b>CFSTD</b>	0.117**	0.381**	0.442**			
<b>EVAR</b>				0.453***	1.062***	
<b>EPSVAR</b>						0.120***
<b>GROWTH</b>		2.937*				
<b>SIZE</b>	0.093***	0.145***	0.250***	0.096***	0.210***	0.273***
<b>Adj. R<sup>2</sup></b>	0.348	0.613	0.864	0.448	0.869	0.934

\* Statistically significant at the 10% level

\*\* Statistically significant at the 5% level

\*\*\* Statistically significant at the 1% level

Table 4.3 also shows that the cash flow standard deviation is consistently statistically significant over the shorter 1990 to 2004 period while the earnings standard deviation was significant over the longer 1990 to 2009 period. This observation lends support to the Ismail and Kim (1989) claim that cash flows are superior to earnings as a measure of systematic risk. However, the results also suggest that for periods longer than Ismail and Kim's 15-years, this superiority disappears as more observations become available and estimates become more precise. It appears that the superiority of cash flows over earnings can be attributed to measurement issues, and is evident over shorter periods. The improvement of the relationship between accounting variables and systematic risk is again observed at the portfolio level and for the longer 1990 to 2009 period.

The stepwise regression approach was repeated at the individual share, 3-share portfolio and 6-share portfolio levels. Only accounting variables which were significant at the 10% level or better were retained and the following models were arrived at for the individual shares, 3-share portfolios, and 6-share portfolios, respectively, using the full sample period of 1990 to 2009<sup>2</sup>:

<sup>2</sup> The relevant t-statistics appear in parentheses in each equation.

$$\beta_i = -1.107 + 0.455\text{EVAR} + 0.12\text{SIZE} - 0.107\text{CR}$$

(2.770) (5.834) (4.779) (-1.693)

$$\beta_{3\text{sp}} = -2.556 + 1.024\text{EVAR} + 0.236\text{SIZE} - 0.258\text{CR}$$

(-4.537) (6.427) (9.478) (-5.766)

$$\beta_{6\text{sp}} = -3.472 + 0.12\text{EPSVAR} + 0.273\text{SIZE}$$

(-8.213) (8.516) (8.813)

where:  $\beta_i$  is the beta for the individual share;

$\beta_{3\text{sp}}$  is the beta for a 3-share portfolio; and,

$\beta_{6\text{sp}}$  is the beta for a 6-share portfolio.

The final models developed suggest that investors holding shares in three companies should pay more attention to the variability in earnings, firm size, and current ratio when estimating systematic risk. The results also suggest that investors holding shares in at least six different companies should focus on the size of their portfolio and the variability in the earnings of the companies held.

#### 4.2 Forecasting Ability

The error statistics from the out-of-sample forecast tests are displayed in Table 4.4.

**Table 4.4: Forecasting Ability**

<b>Beta</b>	<b>RMSE</b>	<b>MAE</b>	<b>Theil's U- Statistic</b>	<b>Bias Proportion</b>	<b>Variance Proportion</b>	<b>Covariance Proportion</b>
<b>Panel A: Individual Share Level</b>						
$\beta_m$	0.420	0.331	0.318	0.000	0.528	0.472
$\beta_{acc}$	0.379	0.288	0.281	0.000	0.321	0.679
<b>Panel B: 3-Share Portfolio Level</b>						
$\beta_m$	0.208	0.146	0.147	0.000	0.058	0.942
$\beta_{acc}$	0.164	0.140	0.115	0.000	0.035	0.965
<b>Panel C: 6-Share Portfolio Level</b>						
$\beta_m$	0.213	0.168	0.153	0.000	0.068	0.932
$\beta_{acc}$	0.047	0.038	0.033	0.000	0.006	0.994

$\beta_{acc}$  is the beta derived from the cross-sectional accounting variables model

The accounting variables models have lower error statistics at the different shareholding levels than the constant beta model. An analysis of Theil's U-statistics reveals that both the models have lower bias and variance proportion at the portfolio level than at the individual share level. Again, this provides evidence in favour of the measurement error reduction effects of portfolio formation. Since a model with lower bias and variance proportion is preferred, the accounting variables models will be consistently preferred to the naïve market model.

## **5 SUMMARY AND CONCLUSIONS**

The results of the various models employed in this study indicate that a statistically significant relationship exists between systematic risk and accounting data. The existence of a significant relationship between accounting data and systematic risk observed in this study is in line with previous research, although differences exist in terms of the variables identified as relevant. For instance, the dividend payout ratio which was reported as statistically significant in previous studies (Beaver *et al*, 1970; Castagna and Matolcsy, 1978; Bowman and Bush, 2006) was not found to be significant in this study. The accounting variables found to be most significant were earnings variance, size, and liquidity. The most intriguing observation made in this study relates to the positive and statistically significant relationship between beta and size. Although this observation is not entirely unprecedented, it represents a departure from the conclusions reached mainly in the U.S. and other developing countries such as Canada (Berkowitz, 1998). Castagna and Matolcsy (1978) and Brimble (2003) have both reported a positive relationship between size and systematic risk using Australian data. In the South African setting, Bergesen and Ward (1996) arrived at the same conclusion. Therefore, the statistically significant positive relationship between size and systematic risk observed in this study is in line with the findings made in smaller market similar to South Africa.

The evidence presented in this study contradicts Retief's (1984) finding that financial leverage is the single most important accounting variable in the South African context, as financial leverage is not found to be statistically significant and financial leverage exhibits a negative relationship with beta instead of the premised positive one. The conflicting results may be as a result of the fundamental market changes which have occurred since Retief's study in 1984 but the issue warrants further investigation.

Tests for the forecasting ability of accounting data indicate that the accounting data-based model performs better than the naïve beta model in predicting systematic risk. Accounting data may thus provide a viable alternative to estimating systematic risk which has far reaching implications for the valuation of projects and businesses where market data is not directly observable.

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