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Testing the International Capital Asset Pricing Model's relevance for South Africa

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Abstract

The Capital Asset Pricing Model (CAPM) has proven to be a very popular tool for use by financial analysts and investors. The increasing globalisation of world financial markets, however, has called into question its ability to fully capture the risks inherent in a more internationally integrated financial environment. As a result two alternative versions of an International CAPM (ICAPM) have been proposed: the single-factor ICAPM model developed by Grauer, Litzenberger and Stehle (1976), and a multifactor ICAPM model first introduced by Solnik (1974).

This study tests the suitability of the ICAPM models in a South African context. The Fama-Macbeth (1973) two-step approach is employed to test the performance of a domestic CAPM and two ICAPM models for listed stocks on the Johannesburg Stock Exchange. We find support for use of a multifactor ICAPM model in the South African environment.

Given the pivotal role the CAPM plays in Corporate Finance this finding has important implications for managers, analysts and investors estimating the appropriate required rate of return of South African investments.

Key phrases

Capital Asset Pricing Model; currency risk; International Capital Asset Pricing Model and market segmentation

JEL: F36, F65, G12

1. INTRODUCTION

The Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965) has proven to be an invaluable tool for investors seeking to evaluate investment opportunities. International studies, see for example Graham and Harvey (2001:201) and Brotherson, Eades, Harris and Higgins (2013:18) have both found that the CAPM is the most popular model used by both academics and practitioners. Similar studies in South Africa such as Correia and Cramer (2008:41) and PriceWaterhouseCoopers (2017:32) have also found that the CAPM is used extensively by investment analysts.

The persistent usage of this model is due in large part to its inherent simplicity and intuitive appeal, since the only factors that are required for its estimation are proxies for the risk-free rate and market portfolio, and a measure of the systematic risk of an asset. Whilst there are many different proxies that can be used for the risk-free rate, historically the proxy used for the market portfolio is that of a broad-based index specific to the domestic country of an investor. This standard form of the CAPM model however, should only hold for a capital market in which there is only one currency, and which is totally segmented from other capital markets which have different currencies (Balvers & Klein 2014:215; Lewis 2017:379). Since 2000 the process of globalisation, particularly the free mobility of capital (Carp 2014: 351) has caused greater financial integration amongst different countries, making the assumption of market segmentation increasingly questionable, suggesting a need for a model more suited to the globally integrated financial environment.

Solnik (1974) first investigated the idea of an International CAPM (ICAPM). His multifactor model was built on the assumption that Purchasing Power Parity (PPP) does not hold, and therefore he included the use of a global market index as a proxy for the market portfolio, as well as additional exchange rate risk factors. This model was later followed by that of Grauer et al (1976) who, under different assumptions, developed an ICAPM model which excluded exchange rate factors and only incorporated a world market index. Whilst these ICAPM models differ in the parameters necessary for implementation, a condition necessary for both models to hold is that the country being tested should be integrated into the global economy.

Whilst Harvey (1995:812), Garcia and Ghysels (1998:464) and Carrieri, Errunza and Hogan (2007:915) all find that emerging markets are largely segmented, other studies such as Bekaert and Harvey (1995:437), De Nicolo and Juvenal (2014:65), Karwowski and Stockhammer (2017:84) and Taskin and Muradoglu (2003:543), find support for the hypothesis of integration in emerging markets. Many of these studies excluded South Africa from their analyses as, at the time, the country was not included in emerging market databases. Studies based on South Africa by Farid (2013:5), Hammoudeh, Kang, Mensi and Nguyen (2016:1714), Lamba and Otchere (2001:222) and Marais (2008:71), however, have shown that whilst South Africa may not be fully globally integrated (commonly referred to as market segmentation), the level of integration is steadily increasing over time. The possibility therefore exists that global factors may exhibit a significant influence on asset returns experienced, in which case the ICAPM models should hold. If, on the other hand, the South African market is found to be segmented, the standard form of the CAPM, also known as the Domestic CAPM (DCAPM) should be found to be sufficient in the explanation of expected returns.

The purpose of this paper is therefore to evaluate which of these three CAPM models is the most appropriate for capturing the risks inherent to the South African economy. For simplicity, and based on the differences between the two ICAPM models, the single-factor Grauer *et al.* (1976) model will be referred to as the ICAPM, whilst Solnik's (1974) multifactor model will be referred to as the ICAPM^{EX}.

2. LITERATURE REVIEW

The first test of the single-factor ICAPM model was conducted by Stehle (1977:500), who used a variation of the Fama-Macbeth method of two pass regression (FM method), in order to evaluate how US assets were priced over the period of 1956 to 1975. His test evaluated whether the market was segmented by using the DCAPM, whereas the hypothesis of integration was tested by utilising the ICAPM model. Stehle's (1977:501) results were in favour of the ICAPM model however these results are considered to be weak since at that time the US index constituted more than 40% of the world portfolio which resulted in strong collinearity between the US index and the world index (Karolyi & Stultz 2002:26).

The weakness inherent in Stehle's (1977) test prompted Jorion and Schwartz (1986:612) to investigate whether the Canadian market was segmented or integrated over the period of 1963 to 1982 by examining 750 individual assets in Canada. Their study also took on an additional dimension due to a significant proportion of Canadian stocks also being listed in the US, which allowed them to compare the performances of the interlisted stocks with the purely domestic ones. They found that whilst national factors were priced, the null hypothesis of integration was strongly rejected across all portfolios, implying that the ICAPM did not hold for both the domestic and the interlisted stocks. Mittoo's (1992:2053) replication of the Jorion and Schwartz study also found evidence in favor of the segmentation hypothesis. However, he also found that this result changes over different time periods, with integration being displayed over the later years of his study.

Wu (2002 and 2008) utilised a variation of the FM method to evaluate both the domestic version of the CAPM as well as the $ICAPM^{EX}$. The data used in his study consisted of 16 countries, with the inclusion of the exchange rate information of the German Deutschemark, Japanese Yen and British Pound (with the dollar as the base currency). Whilst Wu's (2002:15) results found that none of the exchange rate factors were priced, he also found that the international form of the model still consistently exhibited greater explanatory power than the domestic form. When this 2002 study was extended to evaluate the forecasting ability of each model in his 2008 study, his results again found that the $ICAPM^{EX}$ model consistently performed better than the DCAPM (Wu 2008:182).

The previous studies outlined were all conducted using international data. The corresponding literature testing the ICAPM in South Africa, however, is very sparse, with, to the best of our knowledge, only two unconditional tests of the ICAPM models being conducted thus far. The first study, conducted by Harvey (2000:16) utilised data from both developed and emerging markets to test the appropriateness of the single factor ICAPM model, which he found to be priced in both markets. In addition, he found that the ICAPM model displayed greater explanatory power in emerging markets, with the average R^2 value for emerging markets being 5% higher than those produced in developed markets. You, Ghai amd Welch (2006:4178) also evaluated the DCAPM and ICAPM models by using 704 multi-listed companies from 59 different countries (including South Africa) and also consistently found that the ICAPM model outperformed the DCAPM in terms of explanatory power.

Whilst Harvey (2000) and You *et al.* (2006) both evaluated the DCAPM against the single-factor ICAPM model, there is no South African study that we are aware of, that has evaluated the ICAPM with exchange rates. Instead, there have been studies which looked at the relevance of exchange rate risk factors in the explanation of expected returns, independent of the $ICAPM^{EX}$ model. Barr and Kantor (2005:85) found that of their total sample of the Top40 JSE firms 60% of the firms in the sample exhibited significant currency exposure. Barr, Kantor and Holdsworth (2007:51), using the same sample but a more sophisticated methodology, found evidence that exchange rate factors are time-varying, and had exhibited an increasing influence on South African assets in the latter period of their study.

Doidge, Griffin and Wiliamson (2006:573) also provided support for the inclusion of exchange rate factors in an asset pricing model. An analysis of their results shows that on average the inclusion of the exchange rate factor added 2.1% to the explanatory power of the models, whereas for the emerging markets this value increased to 6.3%. For South Africa it was found that the inclusion of the currency factor increased the explanatory power of the model by 2.9% (Doidge *et al.* 2006:558).

Knudsen (2009:41) assessed the differences between the DCAPM and ICAPM for the twenty developed countries included in the MSCI World Index, over the 20 year period of 1989 to 2008 and found that, whilst the R^2 values produced for each of the models were very similar across all twenty countries, the DCAPM was marginally superior to the ICAPM. Bekaert, Hodrick and Zhang (2009:2602) evaluated the single factor ICAPM model against an international Arbitrage Pricing Theory (APT), and an International Fama and French Model in order to identify which model is superior when applied to all the firms in the MSCI World index over the period of 1980 to 2005. They applied a forecasting method of analysis, and found overall that the International CAPM model performance was poor relative to the other two models, as it produced the highest Mean Squared Error (MSE) estimates. However, it was found that when local factors were included into the models, this improved the performance overall.

A recent study by Brusa, Ramodorai and Verdelhan (2015:35) utilised Ordinary Least Squares (OLS) to evaluate the performance of both the ICAPM and $ICAPM^{EX}$ models in 46 different countries, including South Africa. They found that the $ICAPM^{EX}$ produced marginally higher R^2 values than the ICAPM model for South Africa, over the sample period of 1976 to 2013 (43.57% vs 42.44%). This result was consistent across all countries except Japan and the UK, where there was clear superiority of the $ICAPM^{EX}$, primarily due to the Japanese Yen and UK Pound being included as exchange rate factors in the $ICAPM^{EX}$ model. When evaluating the forecasting ability of these models, it was again found that the multifactor ICAPM model produced lower Mean Absolute Percentage Error (MAPE) and Root Mean Square Error (RMSE) values – reinforcing its superiority over the single factor model.

Whilst the results of these studies are mixed overall, there is sufficient evidence to suggest that the ICAPM models may be more appropriate for use in the South African environment. The methods followed to test this hypothesis are therefore outlined in Section 3.

3. METHODOLOGY

3.1 Empirical models and data

The first of the models tested in this study is the domestic CAPM, or DCAPM, which takes the form:

$$E(R_i) = R_f + \beta_i(R_m - R_f) \qquad (1)$$

Where $E(R_i)$ represents the expected return on the asset, R_f represents the risk free rate, β_i represents the beta of the asset and R_m represents the return on the domestic market portfolio. The chosen proxy for the risk free rate was the 90 day treasury bill rate, in keeping with the studies of Samoulihan (2007:452), and Alagidede, Koutounidis and Panagiotidis (2017:181). Similarly, the proxy used for the domestic market portfolio was the JSE All Share Index (ALSI). The second model is the single-factor ICAPM model developed by Grauer *et al.* (1976:241), which can be represented mathematically as:

$$E(R_i) = R_f + \beta_{iw}(R_w - R_f) \qquad (2)$$

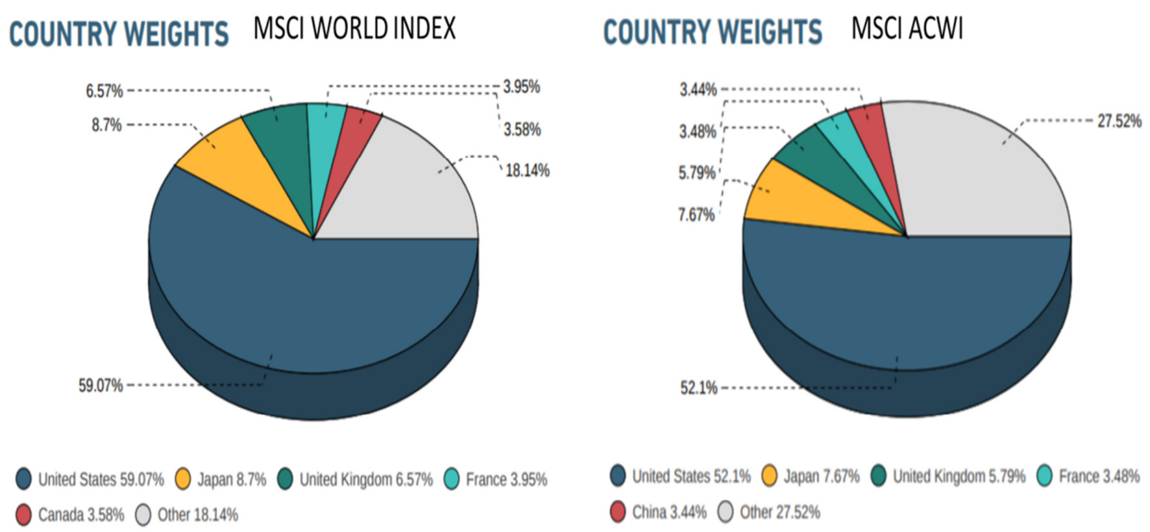
Whereas the DCAPM made use of a domestic market index, this form of the CAPM makes use of a world market index (R_w).

In accordance with Harvey (1991:153) and Harvey and Zhou (1993:129) who found that the MSCI world index is mean-variance efficient and is therefore appropriate for use in the CAPM model, the MSCI world index was utilised as a proxy for the global market. A possible problem faced in South Africa however, is that the MSCI World Index is made up of 23 developed economies only, which implies that it may not be able to sufficiently capture the risks present in an emerging market such as South Africa. Therefore the MSCI All Country World Index (ACWI) was also used as a market proxy as it has greater exposure to developing markets making it arguably more appropriate for the South African context.

The third model investigated in this study is the multifactor ICAPM model (ICAPM^{EX}). Since the ICAPM^{EX} incorporates both the world market index as a factor as well as exchange rate risk, the exchange rates that would be expected to have the most significant influence on the returns of the shares included in the market index were used. The currencies of the countries/regions which hold the largest proportions in the MSCI world index, and MSCI ACWI (as shown in Figure 1) were thus included. It can be seen that the largest portion of both indices is occupied by the US (59% and 52% respectively), followed by Japan (9% and 8% respectively) and the UK (7% and 6% respectively), reflecting the relative dominance by market capitalisation of US firms. Of the remaining countries included in the indices, the next largest portion in both indices is attributed to countries which come from the Eurozone. These four regions, which collectively account for a major proportion of the world portfolio, and a large portion of the ACWI as well, also represent major trading partners to South Africa and any fluctuations in their exchange rates will significantly affect the country's economic position, and more specifically its asset returns.

The four currencies used in this study are therefore the US dollar, British pound, the euro and the Japanese yen[1], all of which are expressed in terms of the *numeraire* currency, which in this case is the Rand. The equation for the ICAPM^{EX} model is shown as follows:

FIGURE 1: Country composition of the MSCI World and WCWI Portfolios



Source: MSCI 2017a: Internet; MSCI 2017b: Internet

$$E(R_i) = R_f + \beta_w(R_w - R_f) + \beta_1 SRP_{USA} + \beta_2 SRP_{Japan} + \beta_3 SRP_{Eurozone} + \beta_4 SRP_{UK} + \beta_5 SRP_{SA} \quad (3)$$

Where SRP refers to the foreign currency risk premiums on the currencies of the USA, Japan, the Eurozone and the UK. It is important to note that the fifth factor ($\beta_5 SRP_{SA}$) will equate to zero as it represents the R/R exchange rate. This ICAPM^{EX} model was run twice using both the MSCI and ACWI as world market proxies. The dollar was found to be highly

[1] Although China is a major South African trading partner the yuan was excluded to avoid multi-collinearity in the analysis as the yuan is pegged against the US dollar.

correlated with both indices and so was excluded from the regression to avoid problems of multi-collinearity.

The start date for the analysis was taken as February 1990, which coincides with the unbanning of the African National Congress, and was identified by both Brooks, Davidson and Faff (1997:9), and Makina and Negash (2004:150) as being the start of South Africa's financial integration. The study used the monthly returns on every single asset which was listed on the main board of the Johannesburg Stock Exchange (JSE) from February 1990 until December 2015, and which had at least 60 consecutive months of data to allow for beta estimation.

3.2 Fama-Macbeth (1973) method of two-pass regression

The most popular method for this type of analysis is that of Fama-Macbeth's (1973) two-pass regression model. In addition to being easy to implement and widely utilised in literature, an advantage of this method is that it allows for time-variation of the beta estimates (Cochrane 2005:251). Whilst Fama and Macbeth (1973:615) made use of beta-sorted portfolios in their analysis, this study hypothesized that industry portfolios would be better suited to a study of the international CAPM models, as it would allow one to further analyse the results with reference to each specific industry and its respective characteristics. This approach is similar to that used by McKenzie, Brooks and Faff (2000) who also made use of industry portfolios in the Australian environment. The use of industry portfolios is also very important for the detection of exchange rate exposure (Krapl & Giaccotto 2015:75). This result was confirmed by the studies of Bredin and Hyde (2011:1128) and Chaeib and Mazotta (2013:782) who found that the presence and extent of exchange rate exposure is affected by industrial structure. The share data obtained was therefore divided into 20 equally weighted industry portfolios and is presented in table 1:

TABLE 1: Industry portfolio classification

Industrial transportation	Automobiles and parts	Building and construction	Technology and electrical
Banks and financial services	Chemicals, oil and gas	Platinum, diamond, coal and precious metals	Personal and household goods
Property	General mining	Industrial engineering	Travel and leisure
Healthcare	Gold mining	Insurance	Food and beverage

Media	Basic resources	Other industrial	Retail

Source: Authors' own construction

The first pass entailed calculation of the portfolio betas by making use of rolling regressions of the excess return of the portfolio, against the independent variables, which in the case of the DCAPM and ICAPM models was the designated market portfolio; and in the case of the ICAPM^{EX} was both the market portfolio as well as the exchange rate risk factors. The general regression equation used is as follows:

$$E(R_{pt}) - R_{ft} = \alpha_{pt} + \beta_{pmt}(R_{mt} - R_f) + \; + \sum_{j=1}^{J} \beta_j RP_j + \varepsilon_{pt} \qquad (4)$$

where there are *j* explanatory variables in the equation, $E(R_{pt})$ is equal to the rate of return on the portfolio *p* at time *t*; R_{ft} is the risk free rate at time *t;* α_{pt} represents the intercept of the regression; RP_j is equal to the risk premium associated with the j^{th} explanatory variable and β_j refers the beta of the portfolio with respect to the j^{th} explanatory variable. ε_{pt} in equation 4 refers to the random error term of the regression at time *t.*

Rolling regressions of equation 4 were used to ensure time-variation of the beta estimates included in the study. The initial regression was therefore conducted over the first 60 months of data (Feb 1990 – Jan 1995) to estimate the first set of beta estimates. Thereafter, the estimation period was rolled forward monthly and re-estimated until the final date of December 2015. This data set produced for use in the second pass of the FM method resulted in both cross-sectional and time series data, as each of the 20 portfolios used had beta estimates for each of the months spanning January 1995, up to December 2015. Data for the JSE indices, used for constructing market-capitalisation weighted portfolios, only start in 2002 and therefore the sample period using market-capitalisation weights runs from 2007 to 2015.

A common method used to deal with data of this sort is to make use of a single pooled regression. However, this method relies on the assumption that the resultant variables and their relationships remain constant over time and across all twenty portfolios used, which therefore implies that the resultant error terms are uncorrelated across observations (Brooks 2014:529). If this assumption is violated, it results in understated standard errors, and incorrect coefficient estimates (Cochrane 2005:301) which in turn leads to inflated t-statistics, which ultimately may result in incorrect inferences about the model being tested (Skoulakis 2006:2). Fama and Macbeth (1973:615) chose to correct for this possibility by running monthly cross-sectional regressions and thereafter averaging the results however, according to Brooks (2014:488), this method is limited as it does not allow for any variation in the variables over time.

An alternative method which allows one to incorporate any unobserved heterogeneity in the data used, is a panel data model. The use of this model may also reveal dynamics and complexities in the data set that would have been difficult to detect with any other method (Baltagi 2005:5). We therefore estimated the second pass regression using a panel data approach. We employed both the Hausman and Redundant Fixed Effects Tests to determine the optimal form for the panel data analysis, both of which found evidence of fixed effects.

The second pass of the FM method therefore regressed the average excess portfolio return over the sample period against the beta estimates obtained from the first pass regressions. The equation and hypotheses tested are as follows:

$$E(\overline{R_{pt}}) - R_{ft} = \gamma_0 + \gamma_{mt}\beta_{pmt} + \sum_{j=1}^{J} \gamma_{jt}\beta_{jpt} + \varepsilon_{pt} \qquad (5)$$

Hypothesis 1 $H_o: \gamma_0 = 0$

$H_1: \gamma_0 \neq 0$

The variable γ_0 is the intercept of the regression, which according to the CAPM theory should be statistically insignificant (i.e. the null hypothesis of $\gamma_0 = 0$ should fail to be rejected), in order for any of the CAPM models to hold empirically.

Hypothesis 2a $H_o: \gamma_{mt} = 0$

$H_{1:} \gamma_{mt} > 0$

Each CAPM model used in the analysis made use of a market portfolio. Since the theory surrounding the CAPM implies that γ_{mt} (which is representative of the market risk premium) should be positive, this is also regarded as a condition necessary for the CAPM model to hold.

Hypothesis 2b $H_o: \gamma_{jt} = 0$

$H_{1:} \gamma_{jt} \neq 0$

This hypothesis refers to the ICAPM^{EX} model and is representative of the exchange rate risk factors. If the ICAPM^{EX} model holds in the South African environment, the exchange rate variables should be found to be statistically significant.

In addition to testing the coefficients of the regression equations, several information criteria, specifically R^2, adjusted R^2 (R^2_{adj}), Shwartz Bayesian Information Criterion (SBIC), Akaike Information Criterion (AIC) and the Hannan-Quinn Information Criterion (HQIC), were compared to evaluate which model is superior.

4. EMPIRICAL RESULTS

The adjusted R^2 values produced during the rolling first pass regressions were collected for each model, and averaged for each model and industry portfolio across the entire sample period. The results are displayed in Table 2. It can be seen that over the full sample estimation period of February 1990 to December 2015, the domestic CAPM outperformed all of the international models in terms of explanatory power for 19 out of the 20 portfolios. The performance of both single-factor ICAPM models was found to be poor across all the industry portfolios, as the average R^2_{adj} values for both models was less than 7%. The $ICAPM^{EX}$ (ACWI) model is the one that provides performance very comparable to the DCAPM model, with the adjusted R^2 values differing by only a few percentage points for certain industries such as Media, Retail and Travel and Leisure. This model is also only considered superior for one of the 20 industry portfolios. Furthermore, the overall average adjusted R^2 value for DCAPM is 27.25%, whilst that for $ICAPM^{EX}$ (ACWI) is 21.34%, a difference of approximately 6%.

TABLE 2: Average adjusted R2 values per industry portfolio: 1995 - 2015

	DCAPM	ICAPM (MSCI World)	ICAPM (ACWI)	$ICAPM^{EX}$ (MSCI World)	$ICAPM^{EX}$ (ACWI)
Automobiles and parts	29.51%	2.80%	8.82%	11.61%	25.52%
Banks and financial services	43.75%	3.75%	8.62%	14.08%	32.12%
Basic resources	26.41%	2.89%	9.70%	10.78%	21.07%
Building and construction	28.87%	3.60%	5.82%	11.52%	21.39%
Chemicals, oil and gas	26.59%	1.31%	6.80%	6.15%	14.54%
Industrial engineering	18.33%	1.59%	3.15%	7.53%	12.12%
Food and beverage	30.61%	2.56%	5.96%	12.00%	20.56%
General mining	35.38%	1.90%	11.59%	12.45%	24.97%

Gold mining	15.26%	1.87%	2.54%	7.93%	8.85%
Healthcare	15.34%	4.55%	2.86%	12.05%	20.72%
Insurance	37.66%	6.47%	6.94%	17.55%	33.23%
Media	23.61%	2.63%	8.41%	8.88%	22.81%
Other industrial	33.93%	2.93%	6.46%	15.88%	26.63%
Personal and household goods	17.87%	3.03%	6.07%	7.50%	13.72%
Platinum, diamond, coal and precious metals	29.31%	5.16%	11.37%	15.63%	20.88%
Property	19.48%	3.72%	2.07%	9.75%	13.63%
Retail	32.60%	5.50%	4.03%	17.00%	29.38%
Technology and electrical	36.17%	3.47%	10.07%	11.11%	28.65%
Industrial transport	21.58%	2.74%	5.66%	8.68%	16.69%
Travel and leisure	22.72%	2.71%	5.13%	9.62%	19.36%
Average	**27.25%**	**3.26%**	**6.60%**	**11.39%**	**21.34%**

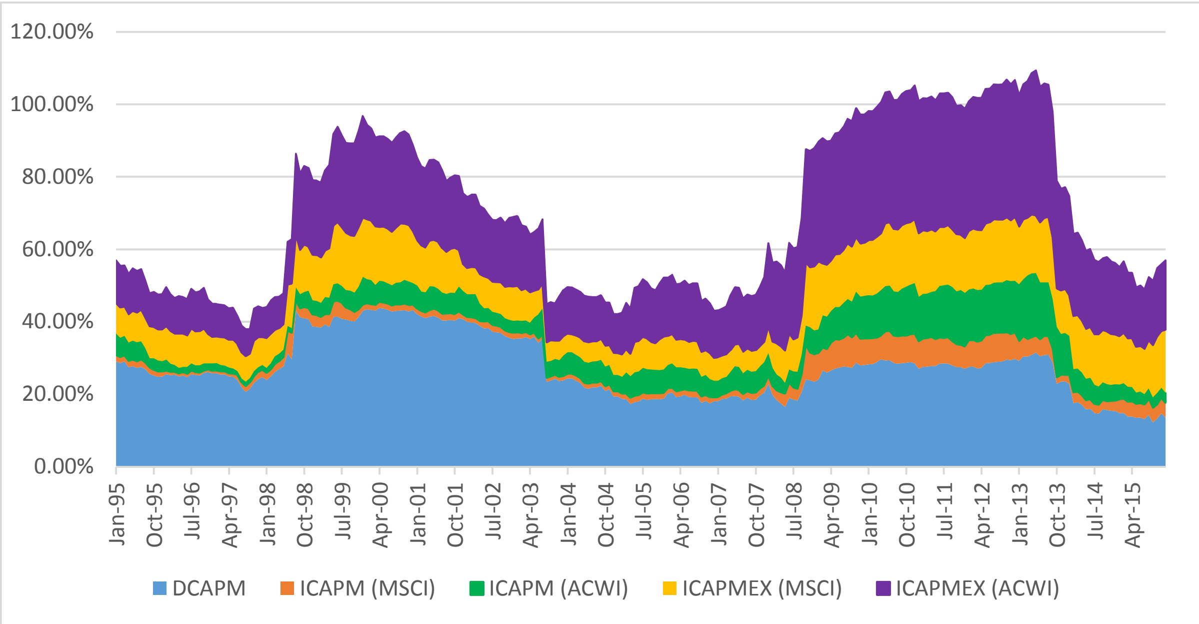
The best performing models are highlighted in grey

Source: Authors' own construction

Given that the level of financial integration in South Africa increased over time, however, there is the possibility that whilst the DCAPM was clearly superior in the former years of the sample period, the international model may have become more appropriate over the latter period. In order to interrogate the change in the models' performance over time, the rolling adjusted R^2 values are therefore displayed as a stacked area graph in Figure 2. While initially the domestic CAPM model displayed the highest explanatory power its influence has clearly decreased over time, particularly since 2008, indicating the greater impact on South African equity returns of risk factors not captured by a beta calculated using only the domestic market reflecting South African firms' greater exposure to international markets. This conclusion is strengthened by the fact that the explanatory power of both international CAPM models has increased over time, with the average adjusted R^2 value of the $ICAPM^{EX}$

(MSCI) model increasing from 7.79% in January 1995, to 17.39% in December 2015. The study sample ended in December 2015, so further tests will need to be done.

FIGURE 2: Stacked area graph of adjusted R^2 values from the rolling first pass regressions



Source: Authors' own calculations

The results of the first pass regressions therefore suggest that South Africa has become increasingly globally integrated with the associated implication that some form of ICAPM may now be more appropriate for evaluating South African investment opportunities.

TABLE 3: Average adjusted R^2 values per industry portfolio: 1995 – 2005 and 2006 – 2015

	Sub sample: 1995 - 2005				Sub sample 2006 - 2015		
	DCAPM	**ICAPM (ACWI)**	**ICAPM^{EX} (ACWI)**		**DCAPM**	**ICAPM (ACWI)**	**ICAPM^{EX} (ACWI)**
Automobiles and parts	37.70%	4.42%	22.22%		20.50%	13.67%	29.16%
Banks and financial services	53.79%	8.01%	23.63%		32.70%	9.31%	41.45%
Basic resources	25.24%	4.94%	12.01%		27.69%	14.93%	31.04%

Building and construction	29.53%	1.76%	9.87%		28.15%	10.28%	34.06%
Chemicals, oil and gas	38.58%	4.04%	14.62%		13.39%	9.84%	14.45%
Industrial engineering	28.33%	3.38%	11.30%		7.32%	2.90%	13.01%
Food and beverage	37.49%	4.03%	14.08%		23.04%	8.07%	27.69%
General mining	29.30%	4.14%	14.12%		42.07%	19.80%	36.91%
Gold mining	22.81%	2.13%	9.67%		6.96%	2.99%	7.95%
Healthcare	10.48%	1.99%	12.28%		20.70%	3.81%	30.01%
Insurance	40.91%	7.00%	28.63%		34.09%	6.88%	38.30%
Media	20.76%	4.88%	15.83%		26.75%	12.30%	30.49%
Other industrial	39.67%	4.74%	20.26%		27.61%	8.37%	33.64%
Personal and household goods	21.61%	1.78%	9.36%		13.76%	10.79%	18.52%
Platinum, diamond, coal and precious metals	24.81%	6.00%	8.71%		34.27%	17.28%	34.26%
Property	25.64%	2.02%	15.11%		12.70%	2.14%	12.00%
Retail	40.44%	4.82%	26.41%		23.98%	3.16%	32.64%
Technology and electrical	42.85%	8.83%	21.57%		28.82%	11.45%	36.43%
Industrial transport	27.56%	4.83%	13.94%		15.01%	6.57%	19.72%
Travel and leisure	25.65%	3.68%	12.76%		19.50%	6.73%	26.61%
Average	**31.16%**	**4.37%**	**15.98%**		**22.95%**	**9.06%**	**27.42%**

The best performing models are highlighted in grey.

Source: Authors' own construction

Whilst Table 2 indicated that use of the DCAPM is appropriate, Figure 2 indicates that while this may have been true for the earlier parts of the analysis, South Africa's increasing level of financial integration may mean that an international form should now be used. The sample was therefore divided into two equal subsamples (1995 – 2005 and 2006 – 2015), and the average adjusted R^2 values for each industry sector across both periods is shown in Table 3. The results from the ICAPM models which utilised the MSCI as the market portfolio are not reported as in all cases the ACWI results were superior. It can be seen in Table 3 that whilst for the initial sub-period of 1995 to 2005 the results are similar to those for the full period, for the later sub-period of 2006 to 2015 the relative performance changes. Most notably, we see that the $ICAPM^{EX}$ model now has higher explanatory power, with this model providing the highest R^2_{adj} values for eighteen of the twenty portfolios, supporting the hypothesis that the influence of exchange rates on asset prices has increased in recent years. This result also differs across the different industry sectors, which may indicate that the type of model which should be used is based on the industry sector in which a company operates.

The sensitivity coefficients which were produced in the first pass were subsequently utilised in the second pass regressions to estimate the risk premium of each factor. The results produced are displayed in table 4. The null hypothesis that the intercept coefficient is statistically equivalent to zero was rejected for all five models indicating that there are additional risk factors not captured and that the CAPM is an insufficient asset pricing model.

In addition, if the CAPM model holds the market risk premium should be statistically significant and positive. This hypothesis was rejected for both single factor ICAPM models as well as the DCAPM, since the market risk premiums in all models were found to be statistically significant and negative. However, when the global indices were estimated together with exchange rates in the multifactor $ICAPM^{EX}$ models, the resultant premiums were both statistically significant, and positive, which conforms to the theory surrounding the models. Each of the exchange rate indices utilised were also found to be statistically significant, with the euro and pound exhibiting a negative correlation with expected returns, which suggests that asset returns in South Africa benefit when the rand strengthens against either of these two currencies. The yen however was found to exhibit positive correlation, which suggests the opposite for this currency.

TABLE 4: Estimated gamma coefficients for the FM second pass regression

Domestic CAPM		
Variable	γ_j	**t-statistic**
Intercept	1.838	36.48***
JSE ALSI risk premium	-2.553	-26.63***
International CAPM (MSCI World)		
Intercept	0.255	13.18***
MSCI World risk premium	-1.945	-20.26***
International CAPM (ACWI)		
Intercept	0.738	29.40***
ACWI risk premium	-0.767	-9.34***
$ICAPM^{EX}$ (MSCI World)		
Intercept	-0.05	-8.61***
MSCI World risk premium	0.96	305.44***
Euro	-0.29	-33.52***
Pound	-0.31	-21.73***
Yen	0.17	9.08***
$ICAPM^{EX}$ (ACWI)		
Intercept	-0.35	-31.88***
ACWI risk premium	1.27	216.88**
Euro	-0.45	-28.83***
Pound	-0.15	-9.52***
Yen	0.56	20.58***

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

Source: Authors' own construction

As mentioned before, a notable factor when looking at the DCAPM model, is that the estimate for the JSE ALSI risk premium is statistically significant over the sample period, however the coefficient produced is negative. Whilst contrary to theoretical expectations, a result of this sort is not unusual as studies such as Pettengill, Sundaram and Mathur (1995:111) and McGill (2005: Internet) also found evidence of negative market risk premiums. In McGill's (2005: Internet) investigation of the historical South African equity premium from 1925 to 2004, she found negative risk premiums consistently over the latter twenty years of her analysis period. This result was also found in the Salomons and Grootveld's (2003:130) study of equity risk premiums in developed and emerging markets, as they discovered that over the period of 1994 to 2001, the average monthly risk premium for South Africa was -0.35%. When evaluated over the two sub-samples, the results, presented in Table 5, show largely the same picture that has been seen over the full sample period. It is again found that the JSE, ACWI and MSCI World Index portfolios exhibit significant, negative premiums over both sample periods, although this value becomes positive for the ICAPM (MSCI) in the latter period of the sample. The sign and significance of the market risk premium and currency premiums in each multifactor model are also found to exhibit the same signs and statistical significance as for the full sample period, with the exception of the euro in the ICAPMEX (ACWI) model which, in the first period, is insignificant, and in the second period becomes positive, although only at a 10% level of significance.

Pettengill *et al.* (1995:105) suggested that a possible reason for a negative market risk premium is if the return on the risk free rate exceeds equity returns for a large portion of the sample. In this study, negative market risk premiums were found on the JSE for 112 out of 241 months or 46.5% of the total sample. Another possible reason for this observation is due to the approach utilised when forming the portfolios. As noted by Ward and Muller (2012:2), the formation of equally weighted portfolios, "results in a very strong bias towards fledgling stocks which we feel is inappropriate". The resultant negative market risk premium may therefore be due to the negative returns of small capitalisation firms during the financial crisis receiving a disproportionately higher weighting in the overall portfolio. The analysis was therefore replicated using 15 representative market weighted JSE listed indices in place of the equally weighted industry portfolios.

TABLE 5: Estimated gamma coefficients for the FM second pass regression over the two sub-periods

	Sub-period 1995-2005		Sub-period 2006-2015	
Domestic CAPM				
Variable	γ_j	**t-statistic**	γ_j	**t-statistic**
Intercept	1.99	20.13***	1.22	7.98***
JSE ALSI risk premium	-2.77	-17.03***	-1.13	-3.06***
International CAPM (MSCI World)				
Intercept	-0.07	-2.44***	1.12	62.31***
MSCI World risk premium	-2.98	-23.03***	2.44	23.92***
International CAPM (ACWI)				
Intercept	0.40	7.63***	0.85	44.61***
ACWI risk premium	-0.14	-0.98***	-0.58	-6.21***
$ICAPM^{EX}$ (MSCI World)				
Intercept	-0.07	-8.31***	0.05	7.46
MSCI World risk premium	0.99	168.05***	0.89	236.37***
Euro	-0.29	-17.40***	-0.49	-34.40***
Pound	-0.22	-10.21***	-0.55	-27.94***
Yen	0.27	6.21***	0.03	1.61
$ICAPM^{EX}$ (ACWI)				
Intercept	-0.52	-30.92***	-0.42	-24.95***
ACWI risk premium	1.18	128.31**	1.34	138.67***
Euro	-0.09	-2.71***	-0.49	-21.91***
Pound	-0.02	-0.88	0.07	1.88*
Yen	0.54	10.17***	0.80	27.38***

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

Source: Authors' own construction

The results obtained are displayed in Table 6. An interesting observation is that using the market capitalisation weighted indices has resulted in dramatically different results. The JSE risk premium has gone from a negative value to a positive value of 0.543. Furthermore, both world indices used in the ICAPM models have become statistically significant in both the single factor models, and are now also positive. When viewing the exchange rate exposure variables, it can be seen that whilst all three exchange rate factors are found to be statistically significant, and the pound is still negatively correlated with returns, the signs of the remaining two exchange rates have changed. Whilst in the original analysis, the euro exhibited a positive coefficient and the yen was negative, the opposite now holds true when dealing with the index portfolios. By design, the market capitalisation weighted indices are heavily biased towards larger shares, so these results suggest that important differences exist between larger and smaller firms regarding their exposures to these risk factors. In particular, the differences observed in the sign of the coefficients for the world indices also indicate important differences in the exposure of larger and smaller firms on the JSE to global risk factors. The fact that the coefficients for the world indices display the appropriate sign also suggest that the asset pricing models being tested are more suitable for use with larger firms.

Overall, the analysis of the coefficients produced from the second pass of the FM method indicates that of the five CAPM models estimated, both of the multifactor $ICAPM^{EX}$ models perform the best in terms of the theoretical assumptions underlying the models as the market risk premium is statistically significant and positive, and the exchange rate factors are all statistically significant.

TABLE 6: Estimated gamma coefficients for the FM second pass regression using JSE indices (2002 – 2015)

Domestic CAPM		
Variable	γ_j	**t-statistic**
Intercept	0.619	8.99***
JSE ALSI risk premium	0.543	7.44***

International CAPM (MSCI World)		
Intercept	0.752	17.48***
MSCI World risk premium	0.829	9.53***
International CAPM (ACWI)		
Intercept	0.703	15.80***
ACWI risk premium	0.875	10.39***
ICAPM^{EX} (MSCI World)		
Intercept	0.62	32.31***
MSCI World risk premium	0.88	48.02***
Euro	0.39	7.55***
Pound	-0.19	-7.33***
Yen	-1.56	-29.81**
ICAPM^{EX} (ACWI)		
Intercept	0.62	32.09***
ACWI risk premium	0.92	45.96***
Euro	0.37	6.93***
Pound	-0.30	-10.28***
Yen	-1.69	-28.58***

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

Source: Authors' own construction

The information criteria from each regression estimated were also collected, and are displayed in Table 7. Whilst the goal is to obtain the model with the highest R^2 and adjusted R^2 values, the AIC, SBIC and HQIC values need to be minimised in order to obtain the best model. The ICAPM^{EX} models consistently produce the highest R^2 and adjusted R^2 values. This result is echoed when observing the AIC, SBIC and HQIC information criteria.

TABLE 7: Information criteria for the FM second pass regressions

Panel A: Equally weighted industry portfolios over the entire estimation period (1995 – 2015)					
	DCAPM	**ICAPM (MSCI World)**	**ICAPM (ACWI)**	**ICAPMEX (MSCI World)**	**ICAPMEX (ACWI)**
R^2	12.38%	7.56%	1.71%	98.22%	95.07%
Adjusted R^2	12.03%	7.19%	1.32%	98.21%	95.04%
AIC	2.658	2.711	2.773	-1.239	-0.219
SBIC	2.685	2.738	2.800	-1.207	-0.188
HQIC	2.667	2.721	2.782	-1.228	-0.208
Panel B: Market capitalization weighted JSE indices over the entire estimation period (2007 – 2015)					
R^2	18.74%	19.83%	20.35%	74.85%	72.96%
Adjusted R^2	12.93%	14.11%	14.66%	74.52%	72.61%
AIC	3.225	3.212	3.205	0.199	0.272
SBIC	3.621	3.608	3.601	0.268	0.340
HQIC	3.368	3.355	3.348	0.226	0.298
Panel C: Equally weighted industry portfolios over the entire estimation period (1995 – 2005)					
	DCAPM	**ICAPM (MSCI World)**	**ICAPM (ACWI)**	**ICAPMEX (MSCI World)**	**ICAPMEX (ACWI)**
R^2	9.97%	16.84%	0.00%	98.22%	96.10%
Adjusted R^2	9.28%	16.21%	0.00%	98.21%	96.06%
AIC	3.160	3.080	3.265	-0.762	0.025
SBIC	3.207	3.128	3.312	-0.709	0.078
HQIC	3.177	3.098	3.282	-0.743	0.044
Panel D: Equally weighted industry portfolios over the entire estimation period (2006 – 2015)					
R^2	0.40%	19.39%	1.59%	98.07%	94.25%
Adjusted R^2	0.00%	18.71%	0.77%	98.06%	94.19%

AIC	1.432	1.220	1.420	-2.509	-1.417
SBIC	1.482	1.271	1.470	-2.452	-1.359
HQIC	1.450	1.239	1.438	-2.488	-1.396

The best performing models are highlighted in grey.

Source: Authors' own construction

The information criteria consistently suggest, therefore, that the $ICAPM^{EX}$ models describe the risk return relationship the best for the South African market. This result is consistent with those of both the first pass analysis as well as the second pass, which suggests that regardless of market capitalisation of firms in South Africa, the multifactor ICAPM model would be a better fit in the current economic environment than the conventional DCAPM model.

As noted earlier, the use of the JSE indices restricted the available period of analysis to the period 2007 to 2015. These results, reported in Panel B, are most suitably compared to the results of the equally weighted industry portfolios presented in Panel D. In both cases we see that the $ICAPM^{EX}$ using the MSCI World index is consistently found to be the best performing model but the explanatory power of the model for the market capitalisation weighted portfolios is much smaller.

5. COMMENT AND RECOMMENDATIONS FOR FURTHER RESEARCH

Given the evidence of South Africa's increasing integration into the world economy since the end of apartheid, the purpose of this study was, therefore, to directly compare the performance of the DCAPM, the ICAPM and $ICAPM^{EX}$ models using all shares listed on the Johannesburg stock exchange in order to determine if an asset pricing model using only a domestic market index or one employing international risk-factors did a better job capturing the risk factors facing South African firms. We find evidence that the explanatory power of the ICAPM and $ICAPM^{EX}$ models has consistently increased over time whilst that of the DCAPM has decreased, supporting the proposition that South Africa's increasing integration into the global economy has increased the exposure of South African firms to global systematic risk factors. However, we also find that while the $ICAPM^{EX}$ model consistently displays the greatest explanatory power, the difference in performance between all three models using equally weighted industry portfolios is marginal suggesting little economic improvement over using the DCAPM.

When we repeat the analysis using market capitalisation weights, however, the superior performance of the $ICAPM^{EX}$ model is substantial indicating that larger firms are more exposed to international risks and that including exchange rate risks greatly improves the explanatory power of the model. This analysis suggests that for larger firms listed on the Johannesburg Stock Exchange the ICAPM may be a superior model for estimating expected returns. Comparing the forecasting ability of each of the models would consequently be a productive area for further research as would further investigation of the role exchange rates play in affecting South African firms' systematic risk exposure.

6. CONCLUSION

This study contributes to our understanding of how exposure to international risk factors affects the returns of South African firms and how this relationship has developed following South Africa's increasing involvement in the global economy in the post-Apartheid era. Given the critical role of correctly estimating the appropriate required rate of return for managers making investment decisions, this study's finding that using an international index and including exchange factors is more appropriate in estimating returns for large South African firms than simply using a domestic index also has important practical implications for managers, investors and analysts.

REFERENCES

ALAGIDEDE P, **KOUTONIDIS N** & **PANAGIOTIDIS T**. 2017. On the stability of the CAPM before and after the financial crisis: panel evidence from the Johannesburg Stock Exchange. *African Review of Economics and Finance* (1):180-189.

BALTAGI BH. 2005. Econometric analysis of panel data. 3rd ed. Chichester, UK: Wiley.

BALVERS RJ & **KLEIN AF**. 2014. Currency risk premia and uncovered interest parity in the International CAPM. *Journal of International Money and Finance* 41, 214-230.

BARR GDI & **KANTOR BS**. 2005. The impact of the rand on the value of the Johannesburg Stock Exchange. *Journal of Studies in Economics and Econometrics* 29(2):77-94.

BARR GDI, **KANTOR BS** & **HOLDSWORTH CG**. 2007. The effect of the rand exchange rate on the JSE Top stocks – an analysis for the practitioner. *South African Journal of Business Management* 38(1):45-58.

BEKAERT G & **HARVEY CR**. 1995. Time-varying world market integration. *The Journal of Finance* 50(2):403-444.

BEKAERT G, **HODRICK RJ** & **ZHANG X**. 2009. International stock return comovements. *The Journal of Finance* 64(6):2591-2626

BROOKS C. 2014. Introductory econometrics for finance. 3rd ed. Cambridge, UK: Cambridge University Press.

BROOKS RD, **DAVIDSON S** & **FAFF RW**. 1997. An examination of the effects of major political change on stock market volatility. *Journal of International Financial markets Institutions and Money* 7:255-275.

BROTHERSON WT, **EADES KM**, **HARRIS RS** & **HIGGINS RC**. 2013. 'Best Practices' in estimating the cost of capital: an update. *Journal of Applied Finance* 23(1):15-33.

BREDIN D & **HYDE S**. 2011. Investigating sources of unanticipated exposure in industry stock returns. *Journal of Banking & Finance* 35(5):1128-1142.

BRUSA F, **RAMADORAI T** & **VERDELHAN A**. 2015. The International CAPM redux. Working paper, MIT Sloan School of Management [Internet: http://www.tinbergen.nl/wp-content/uploads/2015/05/BRV_Manuscript_2015-Adrien-Verdelhan.pdf, 2017-09-13].

CARP L. 2014. Financial globalization and capital flows volatility effects on economic growth. *Procedia Economics and Finance* 15:350-356.

CARRIERI F, **ERRUNZA V** & **HOGAN K**. 2007. Characterizing world market integration through time. *Journal of Finance* 42(4):915-940.

CHAEIB I & **MAZOTTA S**. 2013. Unconditional and conditional exchange rate exposure. *Journal of International Money and Finance* 32:781-808.

COCHRANE J. 2005. Asset pricing. Princeton, NJ: Princeton University Press.

CORREIA C & **CRAMER P**. 2008. An analysis of cost of capital, capital structure and capital budgeting practices: a survey of South African listed companies. *Meditari Accountancy Research* 16(2):31-52.

DE NICOLO G & **JUVENAL L**. 2014. Financial integration, globalisation, and real activity. *Journal of Financial Stability* 10:65-75.

DOIDGE C, **GRIFFIN J** & **WILLIAMSON R**. 2006. Measuring the economic importance of exchange rate exposure. *Journal of Empirical Finance* 13:550-576.

FAMA EF & **MACBETH JD**. 1973. Risk, return, and equilibrium: empirical tests. *Journal of Political Economy* 81(3):607-636.

FARID S. 2013. Financial integration in African emerging markets. Johannesburg: African Economic Conference 2013 (Regional integration in Africa; 28-30 Oct.).

GARCIA R & GHYSELS E. 1998. Structural change and asset pricing in emerging markets. *Journal of International Money and Finance* 17(3):455-473

GRAHAM J & **HARVEY C**. 2001. The theory and practice of corporate finance: evidence from the field. *Journal of Financial Economics* 60:187-243.

GRAUER F, **LITZENBERGER R & STEHLE R**. 1976. Sharing rules and equilibrium in an international capital market under uncertainty. *Journal of Financial Economics* 3:233-256.

HAMMOUDEH S, **KANG SH**, **MENSI W** & **NGUYEN DK**. 2016. Dynamic global linkages of the BRICS stock markets with the United States and Europe under external crisis shocks: implications for portfolio risk forecasting. *The World Economy* 39(11):1703-1727.

HARVEY CR. 1991. The world price of covariance risk. *The Journal of Finance* 46(1):11-157.

HARVEY CR. 1995. Predictable risk and returns in emerging markets. *The Review of Financial Studies* 8(3):773-816.

HARVEY CR. 2000. Drivers of expected returns in international markets. *Emerging Markets Quarterly* 4(3):1-17.

HARVEY CR & **ZHOU G**. 1993. International asset pricing with alternative distributional specifications. *Journal of Empirical Finance* 1:107-131.

JORION P & **SCHWARTZ E**. 1986. Integration vs segmentation in the Canadian stock market. *The Journal of Finance* 41(3):603-614.

KAROLYI GA & **STULTZ RM**. 2002. Are financial assets priced globally or locally? *NBER working paper series*, no 8994 [Internet: https://ideas.repec.org/h/eee/finchp/2-16.html, 2017-09-13].

KARWOWSKI E & **STOCKHAMMER E**. 2017. Financialisation in emerging economies: a systematic overview and comparison with Anglo-Saxon economies. *Economic and Political Studies* 5(1):60-86.

KNUDSEN J. 2009. Testing the developed world: Global CAPM vs Local CAPM. Bergen, Norway: Norges Handelshoyskole (Masters thesis).

KRAPL A & **GIACCOTTO C**. 2015. Foreign exchange risk and the term-structure of industry costs of equity. *Journal of International Money and Finance* 51:71-88.

LAMBA AS & **OTCHERE I**. 2001. An analysis of the dynamic relationships between the South African equity market and major world equity markets. *Multinational Finance Journal* 5(3):201-224.

LINTNER J. 1965. The valuation of risky assets and the selection of stock portfolios and capital budgets. *Review of Economics and Statistics* 47(1):13-37.

LEWIS KK. 2017. Changing risk exposures of cross-listed firms and market integration. *Journal of International Money and Finance* 70:378-405

MAKINA D & **NEGASH N**. 2004. Testing for structural breaks and dating of stock market liberalization: new evidence from the JSE Securities Exchange South Africa. Cape Town, (*13th Annual Conference of the Southern African Finance Association*, Jan.).

MARAIS C. 2008. An evaluation of the South African equity market's progress towards developed market behaviour, Pretoria: University of Pretoria. (MBA dissertation).

MCGILL R. 2005. Equity risk premium: a quantitative perspective. *Quant Matters* [Internet: http://financialmarketsjournal.co.za/oldsite/3rdedition/equityrisk.htm, 2017-09-12].

MCKENZIE MD, **BROOKS RD** & **FAFF RW**. 2000. The use of domestic and world market indexes in the estimation of time-varying betas. *Journal of Multinational Financial Management* 10:91-106.

MITTOO UR. 1992. Additional evidence on integration in the Canadian stock market. *The Journal of Finance* 47(5):2035-2054.

MSCI. 2017_a. MSCI World Index (USD). [Internet: https://www.msci.com/documents/10199/178e6643-6ae6-47b9-82be-e1fc565ededb, 2017-09-12].

MSCI. 2017_b. MSCI ACWI Index (USD). [Internet: https://www.msci.com/documents/10199/8d97d244-4685-4200-a24c-3e2942e3adeb, 2017-09-12].

PETTENGILL G, **SUNDARAM S** & **MATHUR I**. 1995. The conditional relationship between beta and returns. *The Journal of Financial and Quantitative Analysis* 30(1):101-116.

PRICEWATERHOUSECOOPERS. 2017. Closing the value gap: valuation methodology survey. 8th ed. [Internet: https://www.pwc.co.za/en/assets/pdf/closing-the-value-gap-2016-2017.pdf, 2017-09-08.]

SALOMONS R & GROOTVELD H. 2003. The equity risk premium: developed versus emerging markets. *Emerging Markets Review* 4(2):121-144.

SAMOULIHAN N. 2007. The price of risk in the South African equity market. *South African Journal of Economics* 75(3):442-458.

SHARPE W. 1964. Capital asset prices: a theory of market equilibrium under conditions of risk. *Journal of Finance* 19(3):425-442.

SKOULAKIS G. 2006. Panel data inference in finance: least-squares vs Fama-MacBeth. University of Maryland working paper. [Internet: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1108865, 2017-09-13].

SOLNIK B. 1974. An equilibrium model of the international capital market. *Journal of Economic Theory* 8:500-524.

STEHLE R. 1977. An empirical test of the alternative hypotheses of national and international pricing of risky assets. *Journal of Finance* 32:493-502.

TASKIN F & **MURADOGLU G**. 2003. Financial liberalization: from segmented to integrated economies. *Journal of Economics and Business* 55(5):529-555.

WARD M & **MULLER C**. 2012. Empirical testing of the CAPM. *Investment Analysts Journal* 76:1-12

WU H. 2002. Exchange risk versus the value factor in international asset pricing, [Internet: https://pdfs.semanticscholar.org/87f6/b5f588ca24cc0b5cdcd05f2a770991d2dfc3.pdf, 2017-09-13].

WU H. 2008. International asset pricing models: a forecasting evaluation. *International Research Journal of Finance and Economics* 15:175-184.

YOU L, **GHAI GL** & **WELCH WW**. 2006. Estimation of global beta and tests of capital asset pricing models. *The International Journal of Finance* 18(4):4161-4182.