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Study of the risk-return relationship in emerging and less developed african markets

KEYWORDS: Risk-return, GARCH-M model, EGARCH-model

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ABSTRACT This article examines the return volatility of daily indices of share prices of eight African stock markets over the period of February 2004 to November 2012. The objective is to ensure that the risk premium as well as some stylized facts do exist in the stock index of emerging and less developed markets in Africa. The study employs both the GARCH-M and EGARCH-M models to check the symmetric and asymmetric impact of the return volatility of stock indexes. The results show that the use of the symmetric GARCH-M model fails to prove the existence of the risk premium in the index returns. On the other side, the application of the asymmetric EGARCH-M model first reveals significant and positive risk premiums for the markets of Kenya, WAEMU (West African Economic and Monetary Union) and Mauritius; and secondly, significant and negative risk premiums for the markets of Egypt, Nigeria and Botswana.

Introduction

Return volatility is a measure of the intensity of unpredictable changes in the asset returns (Jegajeevan, 2010). It is therefore a parameter for quantifying return risk and price. Hence, it is an indicator for the risk of financial investments.

Indeed, recent empirical literature shows that volatility of financial returns has certain characteristics that are specific to financial time series such as volatility clustering, leptokurtosis and leverage effect. The use of constant variance models is not appropriate in presence of these characteristics. Therefore, to capture these characteristics, financial econometricians developed a variety of volatility models over time. Among them, the Generalized Autoregressive Conditional Heteroscedasticity in-Mean (GARCH-M) has the advantage of better processing the data of financial series that do not meet the basic hypotheses of the classical linear regression model (Yacop and Delpachitra 2006). Thus, the GARCH-M model, introduced by Engle, Lilien and Robins (1987), provides a new framework for the study of the risk-return relationship, since this model explicitly presents the relationship between variance and returns conditional mean. Because of the relative failure of symmetric models in the processing of asymmetric qualities of returns, changes have been made by academics in these symmetric models for better processing of asymmetric distributions in consideration of the risk-return relationship. Among them, the Exponential GARCH-in-mean (EGARCH-M) and the Power-in-mean GARCH model (PGARCH-M) are often the most used.

This article therefore refers to these models to examine the risk-return relationship in eight African stock markets, namely South Africa, Morocco, Egypt, Nigeria, Kenya, Mauritius, Botswana and WAEMU[1].

Thus, one of the contributions of the present article is to provide additional empirical evidence on this relationship in African emerging and frontier markets. The main purpose of the article is therefore to study the relationship between stock returns and their volatility. This paper is organized into three main sections: The first one presents the literature review. The second section examines the data and the methodology used. And finally, the empirical results are provided and discussed.

1. Literature review

Financial theory argues that asset return depends on its level of risk (Markowitz 1952; Sharpe, 1964). Thus, it is widely accepted that the expected rate of market return is positive and proportionally related to conditional volatility (Yakop and Delpachitra, 2006). This means that if there are expectations at higher level of risk associated with a particular investment, then higher returns are needed to compensate for this risk that is expected to be higher. However, in the financial literature, empirical evidence that supports the risk-return relationship in the developed, emerging and less developed stock markets are often mixed, for they give rise to positive, negative or zero relationship. Indeed, for developed stock markets, Campbell and Hentschel (1992), Bansal and Lundblad (2002), Ghysels et al., (2005) and Ludvigson and Ng (2007) found that expected returns are positively related to their conditional variances. In recent studies, Hibbert et al., (2008), studying the question of risk-return tradeoff, found a negative asymmetric relationship between return and return volatility of the S&P 500 index. For emerging countries, Yacop and Delpachitra (2006) used the GARCH-M model to describe the relationship between risk and return in ten stock markets in Asia-Pacific countries, as part of the conditional CAPM. Their result, although not exhaustive, shows that the assessment model of the financial assets still holds in explaining the risk-return relationship for the stock markets of China and Malaysia.

Using the EGARCH-M model, Karmakar (2007) and Saleem (2007) found evidence of a positive and significant risk premium for the markets of India and Pakistan. Jegajeevan (2010) studied the daily and monthly returns of the Colombo Stock Exchange in Sri Lanka to identify the dynamics of the risk-return relationship, and to know whether the asymmetric volatility exists in this market. Following the application of the EGARCH model, he found the presence of asymmetric volatility indicating that the market reacts more to a negative shock than to a positive shock of the same magnitude. It was also noted that the risk-return relation-

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ship is not statistically significant, although it was considered positive. Abdalla (2012) examined, from an empirical point of view, the tradeoff between risk and expected returns for the stock indexes of Saudi Arabia and Egypt during the period from 1 January 2007 to 30 December 2011. He concluded that the dynamic risk-return relationship is very different between the stock markets of Saudi Arabia and Egypt. A negative but not significant relationship between the expected returns and the conditional volatility is found for daily returns in Egypt. On the other side, a positive conditional mean, but not significant, of stock returns is related to the conditional variance on the stock market of Saudi Arabia. For emerging and less developed markets of Africa, Ogum, Beer and Nouyrigat (2005), using the exponential GARCH model in the stock markets of Kenya and Nigeria, found a negative asymmetry in the dividend yield of the Nigerian market, while this asymmetry is positive in the yields of the Kenyan market. The study also reveals a positive and statistically significant risk premium in the dividend yield series of the Nigerian stock market while the risk premium parameter is negative and non-significant in the Kenyan market. Abdalla and Winker (2012) have modeled and estimated return volatility of equity indices on two African markets, Sudan and Egypt, using different univariate specifications of the GARCH models, over the period of January 2006 to November 2010. The results of this study showed that the parameter measuring the risk premium, for the GARCH-M model (1.1), is positive and statistically significant in both markets. The implication is that the increase in volatility is related to an increase in yields.

2. Data and methodology of the study

The study data, which are presented in this section (2.1), help to introduce the analysis of the statistics and preliminary tests necessary for the application of the selected models.

2.1. Preliminary data and statistics

2.1.1 Study Data

Financial time series, used to study the risk-return relationship in this article, are daily closing prices of the indexes of the sampled eight selected stock markets. Data were collected in the Bloomberg database and cover the period from 2 February 2004 to 16 November 2012. Due to the unavailability of information on dividends, yields rates are calculated from the difference between natural logarithms of two consecutive stock indexes of share prices, i.e.:

$$R_t = \ln(P_t) - \ln(P_{t-1}) \qquad (1)$$

P_t and P_{t-1} respectively denote the daily closing prices of the stock market indexes of each country, at time **t** and t-1. In addition, they are all expressed in local currencies.

2.1.2 Descriptive Statistics

To specify the distribution properties of daily return series on the studied stock markets, statistics are presented, in Table 1.

Table 1: Descriptive Statistics

Variables	Obs	Mean	Minimum	Maximum	Std. Dev	Skewness	Kurtosis	Jarque-Bera
Morocco	2295	0.000257	-0.058850	0.050111	0.01021	-0.268634	6.64466	1297.84*** (0.0000)
Egypt	2295	0.000603	-0.179916	0.106013	0.01836	-0.837156	11.7781	7636.5*** (0.0000)
South Africa	2295	0.000538	-0.075807	0.068340	0.01298	-0.177390	6.77479	1374.606*** (0.0000)
Nigeria	2295	6.34e-05	-0.094753	0.117584	0.01112	0.185170	15.5663	15598.03*** (0.0000)
Kenya	2295	0.000122	-0.103401	0.121354	0.01002	0.572991	30.8146	74106.23*** (0.0000)
Botswana	2295	0.000482	-0.079556	0.129798	0.06323	4.909519	125.112	1435132*** (0.0000)
Mauritius	2295	0.000454	-0.207529	0.196841	0.01013	-0.58850	147.166	1987553*** (0.0000)
WAEMU	2295	0.000340	-0.110334	0.081387	0.01049	-0.216144	17.6408	20515.37*** (0.0000)

*, **, *** corresponding to threshold significances of 10%, 5% and 1% respectively

The return series do not conform to the normal distribution, since Jarque-Bera statistics reject the null hypothesis of normality, for all markets. The skewness of the return series proved strictly different from 0. This indicates that the distribution of stock return series is asymmetric; negatively asymmetric (thick tail to the left) for five markets, namely South Africa, Morocco, Egypt, Mauritius and WAEMU (West African Economic and Monetary Union), and positively asymmetric (thick tail to the right) for the other three markets i.e. Nigeria, Kenya and Botswana. Kurtosis for each set of returns is strictly higher than 3, which implies that the distribution of the return series are leptokurtic with thick tails and sharp peaks.

2.2 Study Methodology

The ideal tool to take into account the variations of the variance over time, previously noted, in order to highlight the risk-return relationship, is the GARCH-in-mean model (GARCH-M). In its modeling, it can be substituted by an asymmetrical model such as the exponential GARCH model, in order to more effectively capture the asymmetry in the financial series.

2.2.1 The GARCH-M model

The GARCH-M model is an extension of the GARCH basic model which allows the conditional mean of a sequence to depend on its conditional variance or standard deviation. For this purpose, the simple specification GARCH (1,1)-M

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which follows is used:

$R_t = \mu + \gamma\sigma_t + \varepsilon_t$ (3)

$\sigma_t^2 = \omega + \alpha_1\varepsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2$ (4)

Où $\omega > 0$, $\alpha_1 \geq 0$ et $\beta_1 \geq 0$, and Rt = return on assets at time t, μ = average yield, σt = standard deviation,
εt = residual returns, defined as follows:

$\varepsilon_t = \sigma_t Z_t$ (5)

The constraints $\alpha_1 \geq 0$ et $\beta_1 \geq 0$ are required to ensure that the variance is strictly positive. In this model, the conditional mean equation is written based on the constant, standard deviation (σ_t) of the conditional variance as an explanatory variable, and the error term. The conditional variance (), is a function of the square error of the last period as well as the conditional variance of the previous period. The parameter γ is called the risk premium parameter.

The significant influence of the conditional volatility of stock returns is measured by the estimated coefficient γ representing the aversion parameter relative to risk. A positive and significant value of γ implies that investors were rewarded with higher returns for having borne higher risks.

2.2.2 The EGARCH-M model

The equation of the conditional variance of the EGARCH (1,1)-M model which is used in this document has the following specification:

$$Ln\sigma^2 = \omega + \beta_1 ln\sigma_{t-1}^2 + \alpha_1\left(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| - \sqrt{\frac{2}{\pi}}\right) + \lambda\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad (6)$$

Where ω, β_1, α_1 and λ are constant parameters to estimate and λ is the asymmetry parameter that allows the EGARCH model to take into account the leverage effect. $Ln\sigma^2$ is forecasting volatility coming on the horizon. This means that the leverage effect is exponential rather than quadratic and forecasts of the conditional variance are guaranteed to be positive or zero, ω is the constant and is the conditional variance of the previous period. If λ is negative, leverage effect exists.

3. Empirical Results

The GARCH-M (1,1) model is used to determine the relationship between risk and return in the daily return series of eight African stock markets. The results are shown in Table 2.

Table 2 : Estimation results of GARCH (1,1)-M

Variables	γ	ω	α_1	β_1	$\alpha_1 + \beta_1$	Q2 (12)	ARCH-LM
Morocco	0.0133 (0.8143)	6.80e-06*** (0.0000)	0.1894*** (0.0000)	0.7613*** (0.0000)	0.9507 ------	14.202 (0.288)	0.7854 (0.3754)
Egypt	0.001671 (0.9873)	0.00025*** (0.0000)	0.0415*** (0.0000)	0.9425*** (0.0000)	0.984 -----	21.06** (0.040)	4.91** (0.0267)
South Africa	0.0482 (0.4613)	2.1e-06 *** (0.0035)	0.0946*** (0.0000)	0.892*** (0.0000)	0.9866 -----	14.615 (0.201)	14.72 (0.2567)
Nigeria	0.00099 (0.968)	8.10e-06*** (0.0000)	0.3166*** (0.000)	0.658*** (0.0000)	0.9746 ------	11.574 (0.480)	0.5252 (0.4686)
Kenya	-0.00039 (0.9929)	1.12e-05 (0.9970)	0.3762*** (0.0000)	0.532*** (0.0000)	0.9082 -----	3.833 (0.986)	0.1189 (0.7302)
Botswana	0.04862 (0.2386)	0.00010*** (0.0000)	0.1005*** (0.0000)	0.8901*** (0.0000)	0.9906 -----	15.22 (0.229)	0.0049 (0.9441)
Mauritius	0.00695 (0.8241)	4.68e-06*** (0.0000)	0.5143*** (0.0000)	0.4834*** (0.0000)	0.9977 -----	1.744 (0.999)	0.00087 (0.9763)
WAEMU	0.02801 (0.8376)	2.89e-05*** (0.0000)	0.1568*** (0.0000)	0.5959*** (0.0000)	0.7524 -----	0.8878 (0.9999)	0.8868 (1.0000)
Average					0.943		

*, **, *** corresponding to threshold significances of 10%, 5% and 1% respectively

The results show that the coefficient of risk aversion γ is positive and not significant, both for emerging markets (Morocco, Egypt, South Africa) and for less developed markets (Nigeria, Kenya, Botswana, Mauritius, and WAEMU). Such a result indicates that, for these markets, the expected return is not dependent on the conditional variance. In other words, it shows the lack of risk-return relationship over time. However, this coefficient was negative and not significant for the Kenyan market.

Overall, compared to the risk-return relationship, these results are not exhaustive. The coefficients of risk parameter γ are not significant for all eight emerging and less developed markets. This relative failure of GARCH-M in determining the risk-return relationship may be due to the inability of this symmetric model to consider the asymmetry previously observed in the return series. This is why some authors, including Jegajeevan (2010), suggest the inclusion of the asymmetric impact of financial series in the GARCH-M model to get a better result. Hence the use of exponential GARCH-M model. The parameter estimates of the EGARCH (1,1)-M model are summarized in Table 3.

Table 3 : Estimation results of the EGARCH (1,1)-M model

Variables	γ	α_1	λ	β_1	$Q^2(12)$	ARCH-LM
Morocco	0.04395 (0.4421)	0.2706*** (0.0000)	-0.0276*** (0.0070)	0.928*** (0.0000)	16.944 (0.152)	16.15 (0.1842)
Egypt	-0.338*** (0.0007)	0.0996*** (0.0000)	-0.0540*** (0.0000)	0.9721*** (0.0000)	2.4747 (0.649)	1.415 (0.2341)
South Af-rica	0.0263 (0.6668)	0.1256*** (0.0000)	-0.0939*** (0.0000)	0.9836*** (0.0000)	17.987 (0.116)	17.797 (0.1220)
Nigeria	3.739*** (0.0000)	0.0116*** (0.0207)	0.1238*** (0.0000)	0.3118*** (0.0000)	13.442 (0.338)	1.0077 (0.3154)
Kenya	0.1844*** (0.0014)	0.4930*** (0.0000)	0.0710*** (0.0000)	0.888*** (0.0000)	3.3016 (0.993)	3.216 (0.764)
Botswana	-0.1185*** (0.0000)	0.2155*** (0.0000)	0.0055** (0.0324)	0.993*** (0.0000)	0.4766 (0.490)	0.4757 (0.4905)
Mauritius	0.0718*** (0.0111)	0.3967*** (0.0000)	0.0200*** (0.0043)	0.9812*** (0.0000)	9.682 (0.644)	9.4527 (0.6639)
WAEMU	0.3731*** (0.0006)	0.2655*** (0.00000)	0.04635*** (0.0001)	0.7170*** (0.0000)	1.4381 (1.000)	1.390 (0.9999)
Average				0.846		

* ; ** ; ***, threshold significances of 10%, 5% et 1%.

The results show that for emerging markets the coefficient of the estimated risk premium γ is positive but not significant for the markets of South Africa and Morocco. This implies that the expected returns on these markets are not dependent on the volatility. This result is consistent with that obtained by Makhwiting et al. (2011) for the case of Johannesburg market. However, for the market of Egypt, the coefficient of the risk premium is negative and significant, indicating that returns negatively depend on the conditional variance. This means that investors have been penalized for taking higher risks. This negative risk premium can be attributed, according to LeBaron (1989) and Balios (2008), to the non-synchronization of transactions, when the market is characterized by illiquidity and low transactions. This would force investors to abandon the risk premium in the pursuit of a successful transaction. This result is consistent with that of Abdalla (2012), for the case of Egypt, where a significant and negative risk premium was recorded. However, it contrasts with that obtained by Abdalla and Winker (2012), again for the case of Egypt, where a positive and significant risk premium has been found. In less developed markets, the coefficient of the risk premium is positive and significant for the markets of Nigeria, Kenya, Mauritius and WAEMU, indicating that, for these markets, the expected returns depend positively of the conditional variance, and supports the positive relationship between risk and return. This result is consistent with that obtained by Ogum, et al., (2005), for the case of Nigeria, where a positive and significant risk premium was recorded. But, for the Botswana market, the coefficient of the risk premium is negative and significant. This means that investors have been penalized for taking additional risks in this market.

Furthermore, it should be noted that the results of the estimation of EGARCH-M model in Table 3 show that the coefficient of skewness is negative and significant for all the emerging markets of South Africa, Egypt and Morocco. Such a result indicates that there is the presence of leverage effect for all of these markets; this implies that negative shocks have a higher impact on the volatility than positive shocks of the same magnitude. This result is consistent with that of Makhwiting et al., (2011), for the case of South Africa, and that of Abdalla and Winker (2012), for the case of Egypt. On the other side, for all least developed markets (Nigeria, Kenya, Mauritius and WAEMU), except Botswana, leverage effect parameter is positive. This positivity indicates that positive shocks have a larger impact on volatility than negative shocks of the same magnitude. This result contrasts with the theory of leverage effect, which suggests that negative shocks increase volatility, more than positive shocks of the same magnitude. We can therefore deduce that the theory of leverage effect is not applicable to these markets. This result is consistent, for the case of Kenya, with those of Ogum, Beer and Nouyrigat (2005) who found a positive and significant coefficient of skewness for the Nairobi market index. Unlike, therefore, these markets, there is presence of leverage effect for Botswana market.

In addition, the observation of the results of Tables 2 and 3 shows that the parameters of GARCH (α_1) and (β_1) are all positive and statistically significant. This means that the volatility of returns is persistent for all eight markets and also indicates that there is volatility clustering judging the average value of the sum $\alpha_1+\beta_1$ (0.94) in Table 2 and the average the β_1 (0.84) volatility parameter in Table 3.

Overall, significant relationships (positive and negative) between return and volatility observed through our results (Table 3), at the stock markets of Kenya, WAEMU, Egypt, Botswana, Nigeria and Mauritius, show that on these markets the risk-return relationship is asymmetrical and nonlinear.

Diagnostic tests based on the autocorrelation of the squared residuals and statistics of the ARCH -LM test are

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shown in the last columns of Tables 2 and 3. This analysis shows that the models used in our study are valid for the estimation of risk-return relationship in these markets.

Conclusion

This article has, from an empirical point of view, studied the volatility of returns in the series of stock indexes of eight emerging and less developed markets of African countries from 2 February 2004 to 16 November 2012. The study focused on the existence of the risk-return relationship, leverage effect, volatility persistence and clustering.

The results indicate, especially for all emerging markets, a positive and non-significant risk premium, except for the Egypt market where the risk premium is negative and significant. But, for less developed markets, the risk premium is positive and significant for all markets, except Botswana market where this premium is negative and significant. The positive risk premium means that for these markets, investors have been rewarded by higher returns based on the risk taken. On the other side, the negative risk premium indicates that investors were penalized for having supported higher risks. Consequently, the EGARCH-M model can be useful for practitioners in determining the expected rate of return and the cost of capital on the stock markets of the less developed countries of Africa.

Moreover, volatility persistence and clustering were found on all the eight studied markets. Likewise, the EGARCH (1,1) model -M showed significant evidence of the presence of leverage effect for all emerging markets of South Africa, Egypt and Morocco; this shows that, for these markets, bad news have a greater impact on conditional volatility than good news of the same magnitude. Nevertheless, for the less developed markets of Nigeria, Kenya, Mauritius and WAEMU, the coefficient of skewness is positive and significant; which implies that the concept of leverage effect does not apply to less developed markets, with the exception of Botswana market, where a negative asymmetry was observed, as with emerging markets. The EGARCH-M model appears as the most appropriate model to capture the risk-return relationship on the studied markets.

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