RESEARCH PAPER | Management | Volume : 6 | Issue : 1 | JANUARY 2016 | ISSN - 2249-555X

Empirical Test of The Capital Asset Pricing Model (Capm) on The Equity Market of Nairobi

KEYWORDS: CAPM, risk, yield, model, market

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ABSTRACT *This study targets testing the validity of the CAPM on an African market: the securities market of Nairobi. The CAPM is a model which allows explaining the relation between risk and yield on markets. Many investors are confronted with the challenge of determination with certainty of the yields on their investments as well as with the choice of an optimal portofolio. A model as the CAPM, through which is capable of predicting the yields on an investment, is then of a major importance.*

Thus the objective of this study was to verify if the CAPM can be applied to the equity market of Nairobi. The study is based on the computation of the beta and the positive yields of forty five listed companies on the Nairobi stock exchange. A model of simple regression was used. Tests of significance in a 95 % confidence level were made to appreciate the results of the regression. The analysis of the results revealed a non-applicability of the CAPM to the Nairobi's securities market. The results of the study do not confirm the basic theory of the model according to which there is a straight-line relationship between the risk and the yield of a stock.

Introduction

The passage from the debts economy to the market economy of the capital was concretized in most of the Western countries by the development and the improvement of financial markets.

These financial markets are following a steady growth trend since the 1970s and allow somehow the economic agents to reconcile objectives that were considered opposed up to then.

These objectives are profitability, safety and liquidity identified in the 70s.

To obtain portofolios that reconcile a high level of profitability and a high level of safety (less risked), the actors of financial markets arrange several instruments called financial instruments of assets management.

In facts, Markowitz's works in the 1950s marked the starting point of the modern financial theory concerning the management of financial assets and the functioning of financial markets and which ended in the formalization in a rigorous frame of the relation between risk and profitability of securities.

A few years later, Sharp (1964), Lintner (1965); Mossin (1966) and Black (1972) developed a central model in financial theory which allows to describe in a simple way, the relation linking the profitability of financial assets and their risk: it is the Capital Assets Pricing Model (CAPM).

This model enjoys certain fame not only on the theoretical plan but also in practice. Indeed, it met a striking success with the practitioners because it allows them to quantify the risk incurred by the detention of a financial asset. Thanks to this double fame as well as thanks to the availability of the financial data of the western markets, the very important number of empirical studies trying to verify it's validity, this model in particular as regards the increasing straight-line relationship between risk and yield as well as the reliability of the beta as a financial analysis tool.

These various empirical studies were made up till now, in the great majority of the cases, on the developed markets. The question that arises is to know if it is possible, bearing in mind, the narrow-mindedness of the African financial markets and especially the situation of latency in which they vegetate, to apply them this progress of the financial theory.

Indeed, the African markets are for the most part small, embryonic and several times without true activity: they are growing markets (Tchemeni, on 1995). These markets are also weakly structured with an intrinsic chronic instability linked to the political cycle of their countries (Bourguinat H.Menaï; 1996).

Besides, it is necessary to underline the fact that, with the low correlations of the emergent financial markets with those of the developed countries as the integration of the developed markets increases and that the profits of the diversification tend to be reduced, the emergent stock markets appear as an interesting choice for the portfolio managers in search of new opportunities of investment (Assoé K. and allies, on 1999).

The empirical validation of the CAPM which was already the object of important searches in industrialized countries still remains relevant in the African countries because, from what we know, few works specifically dealt with this question. Thus the present study suggests fundamentally targeting the nature of the relation linking the systematic risk and the yield on the actions on an African stock exchange in particular that of Nairobi.

The answer to the question of the validity of the CAPM on the African market of Nairobi is interesting for many reasons. Above all, the market of Nairobi as any market of underdeveloped countries presents characteristics different from those of the big markets of industrialized countries (regarding organization and regarding size), what can be at the origin of different results. It is also important for the portfolio managers because it allows them to know if the risk of listed securities on the Nairobi stock exchange, such as it is defined by the model, establishes a suited measure

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on which they can base their decision of investment.

In this search, we adopted a quantitative methodology. This methodology was adopted in two stages. The first stage is dedicated to estimate the beta of every stock by the market model of Sharp (1963, 1964). The second stage is dedicated to the check of the straight-line relationship between the financial returns on assets and their systematic risk. Therefore we declined the yields on the securities on their respective beta obtained previously by the market model of Sharp.

The article is divided into three parts. The first one describes the theoretical frame of the research. The second presents the methodology. Finally, the results are presented and analyzed in the third part.

Littérature review
The modern theory of financial assets' valuation rises from the works of Markowitz (1956). It was focused around the model of the price formation and the relation between anticipated profitabilities (market model) and the financial model of valuation of assets (CAPM)

The equation of the CAPM, as follow, $E_p = R_f + (E_m - R_f)\beta_p$ describes a relation of proportion between the profitability of assets and their beta. It quantifies the existing relation between the profitability of any asset and its undiversifiable risk represented by the beta, paid in the market price: E (Rm) - Rf > 0.

This equation is doubtless, one of the most assessed equations in finance. The first empirical applications of the CAPM, among which the classic Black, Jensen and Scholes (1972) and Fama and MacBeth (1973), gave results rather favorable to the model, securities with higher beta appearing to have higher profitability than the others.

After these first empirical results at the beginning of the seventies particularly favorable to the CAPM, first serious criticisms against the model, as well as the discovery of the first anomalies appear at the end of the same decade.

The most well-known criticism is surely the one of Roll (1977), which points out that; it is impossible to calculate with accuracy the profitability of the market portofolio, because it's hard to have better figures than proxies. As such the CAPM would not be testable; assuming the errors of measurement of the market portofolio can fake the results.

However, Stambough (1982) showed empirically that the tests of the model are in the facts, less sensitive to the choice of the proxy or the indication of market than what Roll (1977) was saying.

The theoretical analyses of Kandel and Stambough (1987) and Shanken (1987) went in the same direction, showing that errors of measurement on the market portofolio do not affect the results of the tests of the model unless the correlation between the market index used and the real market portofolio is low enough.

The most important criticism of the CAPM came from Reinganum (1981), Lakonishok and Shapiro (1986), Pitched and Ritter (1989), and especially from the virulent article of Fama and French (1992), which mention the non-existence of any relation between the beta of assets and their average profitability. The end of the beta was then, clearly announced by some authors.

Various expeditious articles were published into conformity with the CAPM criticisms among which; "Bye-Bye to beta" (Dreman, 1992) and "Is Beta Dead Again?" (Grinold,1993).

But despite the fact that some authors were declaring here and there the death of the beta, other authors were presenting their results favorable to the CAPM. We can quote, essentially Black (1993), Chan and Lakonishok (1993), Pettengill, Sundaram and Mathur (1995) and Grunoly and Malkied (1996). Black (1993) considers besides that Fama and French (1992) did not give a good interpretation of their results. Both of them will revert afterwards and rectify their founding; it is not then necessary anymore to continue talking about the death of the beta, but more simply about the insufficiency of this one as a tool to measure the risk (Fama and French in 1996 and 1998).

When it comes to recent studies, we noticed the one of Basu and Chawla (2010). This study aimed to test the validity of the CAPM for the Indian security market and to apply a modern assets evaluation tool to it. The Indian market is considered as developing and characterized by its volatility and growth. The results turn out to be against the CAPM. The authors concluded that the model fails in the explanation of the risk premium of the Indian market, and that it has a performance below expectations. According to them, this failure could be endorsed by factors such as the imperfection of the chosen stock index to approximate the market portofolio or it may be linked to effects of taxes. Finally they assert that although the CAPM is not relevant in the evaluation the Indian financial market assets, the fact remains that it is a reference on which one can base the creation of alternative models.

One of the recent studies we can also quote is from Michailidis, Tsopoglou, Papanastasiou and Mariola (2006) which had targeted the objectives to test the validity of CAPM for Greece financial market and to make a contribution to the financial literature on the stock exchange of Athena. At the end of their study these authors concluded that the results of the performed tests did not allow them to reject in a formal way the validity of the CAPM on the Athena stocks exchange.

Javid and Ahmad (2008) in an empirical study tested the standard CAPM and concluded that the CAPM of Sharpe-Lintner is not adequate for the equity market of Pakistan.

1. Methodology
Within the framework of our research, we adopted a quantitative methodology.

This method is generally used by most of the researchers when it comes to verifying empirically a model. This methodology was adopted in two stages. The first stage consisted in verifying if the market model corresponds to certain criteria of statistical quality which may make it functional, that is if the betas estimated by this model deserve to be used. For that purpose, we are going to estimate the beta of every security by the market model of Sharp (1963, 1964): $r_t = \alpha_i + \beta_i r_m + \varepsilon_t$

The estimations of the parameters α_i and β_i are obtained by the application of the Ordinary Least Squares method (OLS).

The errors ε_t are supposed to satisfy the usual hypotheses of the simple regression model.

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1- $E(\varepsilon_t) = 0$, the expected value of ε_t is 0
2- $E(\varepsilon_t^2) = \sigma^2$, the variance of ε_t is the same for all the values of t.
3- $E(\varepsilon_t \varepsilon_s) = 0$ for i $\neq$ s; ε_t are independent from one another.
4- $E(\varepsilon_t \varepsilon_m) = 0$, ε_t is independent from Rm.

If the previous hypotheses are not respected, of many reliability problems will be noticed when it comes to the value of the regression coefficients in particular β_i.

We are going to test the violation of the fundamental hypothesis of the market model.

So for the study of the market model, we applied several statistical tests of relative validity:

1-Test of normality
2-Test of autocorrelation
3-Test of heteroscedasticity
4-Test of specification
5-Test of stability.

The second stage consisted in verifying if there is an increasing straight-line relationship between the financial returns on assets and their systematic risk. Thus, we declined the average yields on every security on their respective beta obtained previously by the market model of Sharp.

Basing ourselves on the theoretical model of the CAPM, we have

$$E(r_i) = r_f + \beta_i [E(r_m) - r_f]$$

We define $r_i = E(r_i) - r_f$ and $r_m = E(r_m) - r_f$

We finally have $r_i = \beta_i r_m$

Now an obvious test of the traditional form of the CAPM is to adjust

$$r_i = \gamma_0 + \gamma_1 \hat{\beta}_i + e_i$$

We suppose besides that:

$$E(e_i) = 0$$
$$V(e_i) = \sigma^2$$

For every i

For every i

$COV(e_i, e_j) = 0$ For every i different from j

It follows, therefore, that the estimation of such a model should end up giving the following result: $\gamma_0 = 0$ and $\gamma_1 = r_m$

Within the framework of our study we shall make the hypothesis that dividends are immediately reinvested. Thus the yields on the security are calculated by difference of logarithm of the securities closing prices, or $r_t = \ln(p_t / p_{t-1})$

The market portofolio was represented by the general index on the Nairobi stocks exchange.

The Kenyan Treasury note's rate was chosen to estimate the risk-free rate.

Based on these data we proceeded to treatments and come up with results that we analyzed.

3. The results
3.1. Statistical analysis of the yields
Among a total of 45 stocks listed on the Nairobi's stock exchange, 20 (that is 44 %) showed a negative average yield (Chart N°3 in appendix). Thus, in term of yields, the stocks are less performant.

They are also very risky with an excessive volatility (very large standard deviations).

All these results are in accordance with those from the previous studies on emerging markets. Indeed, for Amato and ali (1999), ' 8 of 10 least successful markets in the World were emergent.

Besides Assoé and ali (1999) came up with the conclusion according to which ' the yields on emerging markets are relatively low and have a big volatility, this in comparison with the developed markets '. These results were also confirmed by Bourguinat H., Led (1996).

3.2. Estimate of the systematic risks and the specific risks
The Chart N°1 includes alpha (specific risk) and beta (systematic risk) decliners as well as statistics and the probability related to the validity of the coefficients. It also include the statistics of Fisher and DW used respectively to study the stability and the autocorrelation.

Chart n°1: analysis of the beta and the specific risks of the stocks

			Statistics		Meanings		DW	F-stat
	Alpha	Stupid man	Alpha	Stupid man	Alpha	Beta		
Arm	0.0006	0.4195	0.5953	0.5891	0.6429	2.7843	2.55655	0.282456
Bam	0.0006	1.0132	0.001	0.0485	0.5204	0.0054	2.46035	0.218499
Bbk	0.0005	1.4323	0.921	3.4811	0.3572	0.0005	1.89775	2.273427
Beats	0.0009	1.2853	1.1945	2.2628	0.2325	0.0238	2.08102	2.514636
Boc	0.0003	0.3651	0.5535	0.8463	0.58	0.3975	1.9398	2.634832
Bbo	-0.0004	0.5518	-1.0003	1.7538	0.3173	0.0797	2.48476	2.252089
Cag	-0.0005	0.057	-0.6875	0.1077	0.4919	0.9142	2.00199	0.042435
Coach	0.0003	0.0574	0.4775	0.1082	0.6331	0.9138	1.96123	0.523978
Cfc	0.0003	0.3172	0.5172	-0.6825	0.6051	0.4951	2.09455	2.619102
Ctr	-0.0003	0.2094	-0.3491	0.3057	0.7271	0.7599	1.93636	0.463299
Cmc	0.0005	0.3382	0.7369	0.6294	0.4613	0.5292	1.91474	2.303299
Cbe	0.0007	0.5275	0.7769	0.7557	0.4373	0.4499	1.99407	2.871313
Dtk	0.0003	1.5515	0.4672	3.1469	0.6404	0.0017	1.88217	0.026139
Dun	-0.0016	0.1901	-0.8005	0.1272	0.4235	0.8988	1.95357	2.210402
Ega	-0.0006	0.0316	-1.2171	-0.0894	0.2238	0.9288	2.01269	2.486452
Eap	-0.0011	1.7784	-1.1043	2.4375	0.2696	0.0149	1.99426	0.008122
Eac	-0.0006	0.5834	-0.25	0.3342	0.8026	0.7383	1.9491	2.851924
Kbl	0.0013	0.6652	2.5664	1.7061	0.0104	0.0882	1.92713	0.253652
Ept	0.0004	0.3858	0.4219	0.5611	0.6731	0.5748	1.98673	2.640869
Exp	-0.0012	0.9175	-2.0557	2.1377	0.04	0.0327	2.25882	2.001047
Fir	-0.0005	1.423	-0.6438	2.3791	0.5198	0.0175	2.47885	2.221623
Hfc	-0.0002	1.1781	-0.1986	1.5848	0.8426	0.1132	2.0016	2.231008
Icd	0.0004	0.5223	0.2164	0.3696	0.8287	0.7117	1.95757	2.216080
Jub	0.0002	0.6341	0.4552	1.5508	0.649	0.1212	1.85874	2.220365
Kak	-0.001	1.3285	-1.7388	3.039	0.0823	0.0024	2.00107	0.006223
Kap	0.0003	0.0801	0.8875	0.3451	0.375	0.7301	2.22292	0.067558
Kcb	-0.0003	1.7636	-0.3624	3.8231	0.7171	0.0001	2.41104	2.213783
Kor	-0.0004	0.046	-0.9109	0.1307	0.3625	0.896	1.87051	0.074793
Kpl	-0.0008	1.97	-0.7044	3.6257	0.4813	0.0003	2.00187	2.909315
Lim	0.0003	0.1028	0.3734	-0.1677	0.7089	0.8668	1.85431	2.216607

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Mar	-0.001	0.3718	-0.5926	0.2846	0.5535	0.776	2.0005	0.257127
Nbk	-0.0001	1.4247	-0.0563	1.8	0.9551	0.0721	2.5142	2.781704
Nic	-0.0002	0.8212	-0.1044	0.586	0.9169	0.5579	2.03437	0.479983
Kel	0.0014	0.5865	2.7512	1.488	0.006	0.137	2.86487	0.021957
Nmo	0.0002	1.187	0.1232	1.6172	0.902	0.106	2.12292	2.676386
Piece	-0.0004	0.403	-0.4901	0.6729	0.6242	0.5011	2.08294	0.851376
VIP	-0.0004	1.1443	-0.4189	0.1622	0.6753	0.8711	1.9897	2.219592
Sieve	-0.0006	1.9635	-0.3024	1.8469	0.7624	0.065	2.76206	0.093890
Scb	0.001	1.4556	0.9982	1.8708	0.3183	0.0616	2.5843	0.028357
Sng	-0.0004	1.4956	-0.1346	0.6026	0.8929	0.5469	2.60334	2.218889
Early	0	1.8964	-0.0406	2.0339	0.9676	0.0421	2.58385	2.215390
Tps	0.0004	1.2633	0.4323	1.6787	0.6656	0.0934	2.32237	2.955686
Uch	-0.0003	1.9502	-0.2387	3.0558	0.8114	0.0023	2.42311	0.004583
Ung	-0.0002	1.096	-0.0929	0.6194	0.926	0.5358	2.16863	2.219883
Wtk	0	0.9245	-0.0319	2.1569	0.9746	0.0312		

Source: from the data of the stock-exchange and monetary markets

Among the 45 stocks, 30 or (66 %) have a beta statistically valid; meaning thus that the market model which is used to estimate these coefficients beta would be a priori a model adapted for that purpose, this, before having access to the results of the fundamental hypotheses tests of the.

Among the 45 stocks that have been the object of our study, 26 is (57.77%) have a beta superior to the one (offensive stocks); These stocks over amplified the market fluctuations. The staying 42.23 % have valuable beta lower than the unity. We can conclude that these stocks are defensive. Thus they follow the market' trend.

As for estimated alphas, they are without exception statistically nil. Thus the market of Nairobi does not pay the specific risk. This fact seems to be very interesting in many respects. The non-significance of the alphas coefficients (zero specific risks) undeniably predisposes the beta obtained to be validly used for the CAPM and seems to be a good indicator for the model's validity. Indeed the traditional version of the CAPM opts for a nullity of the specific risk.

3.3. Test on the violation of the fundamental hypotheses of the market model

3.1.3.1- Specificity

The Chart n°4 (in appendix) presents the results coming from the test for the appreciation of the specification. It is a Ramsey's parametric test which uses the ratio of similarity (LR) which is distributed as X_2^2. On 45 stocks having been the object of analysis, more than half are badly specified.

3.1.3.2- Heteroscedasticity

The Chart n°5 (in appendix) presents the results of the heteroscedasticity test of White. It is a test which allows comparing the statistics NR ² with N being the number of observations and R ², the coefficient of determination in X_2^2

It emerges from results of the Chart n°4 that statistics NR ² is smaller than X_2^2 at a level of 0.05 significations.

We can conclude that the model is not homoscedastic. Thus there are heteroscedastic for all the stocks.

This result is in compliance with those obtained later on the small financial centers. It confirms those obtained by Belkaoui (1997) and by Fowler and ali (1979) which respectively used a sample of 45 companies and 69 listed companies on the stock exchange of Toronto. The same results have been reached by Giaccotto and ali (1982) and Karathanassis and Philipas (1993) on the Greek data.

3.1.3.3-Normality

The Chart n°3 (in appendix) presents the statistics of the test of Jarque-Bera as well as their probability. Under the null hypothesis of normality, this statistics of Jarque-Bera is distributed according to X_2^2.

The results of our study brought the proof of no normality of the market model for all 45 stocks.

This question of no normality of the yields on the stocks, even if it tends to concern several financial centers and this without distinction of sizes, it is necessary to note nevertheless that it is more stressed on the small financial stock exchanges. This no normality of the yields does not seem to make relevant the criterion of average variance (Amato and Ali 1999)

3.1.3.4-Autocorrélation

The Chart N°3 presents the results of the tests of autocorrelation of Durbin Watson. It seems that there are a significant number of stocks which are auto-correlated.

Actually on a total of 45 stocks analyzed, 40 (approximately 89 %) are auto-correlated.

3.1.3.5-Stabilité

Charts N°3 and 4 present respectively the statistics of Fisher and the ratios of similarity taken from the stability test of the model. The results of each of these two various tests reveal that it appears the betas are not stable through time.

3.4. Cross section test of the CAPM

The last stage of our search is a test in cross section which consists in declining by least ordinary squares, the average yields on every stock in their respective beta obtained previously by the market model. It is an obvious test of the traditional form of the CAPM which consists in adjusting the equation: $r_i = \gamma_0 + \gamma_1 \hat{\beta}_i + e_i$

Chart N° 2: coefficients of the in cross section regression of the average yields on the estimated beta

DETAILED REPORT				
Statistics of the regression				
Coefficient of multiple determination	0.13581808			
Coefficient of determination R^2	0.01844655			
Coefficient of determination R^2	-0.00438027			
Standard error	0.00116964			
Observations	45			
VARIANCE ANALYSIS				
	Degree of freedom	Sum of the squares	Average of the squares	F-stat
Regression	1	1.1055E-06	1.1055E-06	0.80810854
Residues	43	5.8827E-05	1.3681E-06	

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Total	44	5.9932E-05		
	Coefficients	Standard error	Statistics t	Probability
Constant	-8.5208E-06	0.00027496	-0.03098929	0.97542148
Variable X 1	-0.00020055	0.00022309	-0.89894857	0.3736866

Source: computed from the data of the stock-exchange and monetary markets

The results give us:

$\tau(\hat{\gamma}_0)$ =0.586

$\tau(\hat{\gamma}_1)$ =1.06

We find besides: $\hat{\gamma}_0$ 0.0001014 and 0. 0002005 $\hat{\gamma}_1$ R^2 = 13.58 %

The coefficients $\hat{\gamma}_1$ and $\hat{\gamma}_0$ obtained are statistically equal to zero.

Thus it comes out that the obtained results are unfavorable to the CAPM in its traditional version. Indeed, the relation between the profitability and the beta is not significant because the coefficient $\hat{\gamma}_1$ is worth on average 0.0002005 and its statistics of Student is 1.06, leading to the conclusion that this average is not significantly different from zero. Consequently the stock market of Nairobi does not pay the risk-premium. Thus it seems clear that we do not manage to highlight a linear statistical relation between the yields and the systematic risks.

Finally, the explanatory power of the yields by the systematic risks is not very high because the average R^2 is worth 13.58 %, which is very low because the beta are supposed to be the only factor which determines the profitability and thus should explain them up to 100%.

The main conclusion we can get from this analysis seems to tend to the lack of evidence on the existence of a positive straight-line relationship between the yields on the stocks and their systematic risk.

3.5. Implications of the results

The various results obtained within our research have globally two implications. The first one is related to the attractiveness and stability of securities on the market of Nairobi on both the national and international savings. The second is linked to the applicability on this market of the modern tools of finance in particular the CAPM.

As regards to the capacity of attractiveness of the Nairobi's stock exchange, it emerges from the results of our researches that it is not significant. Indeed most of the stocks present simultaneously a very high global risk and a lesser yield which is even sometimes negative. Thus the rate of under-performance of the stocks on this market is very high. Moreover the results of our studies militate in favor of the non-existence of a risk premium on this market. All this added to the low rate of liquidity which characterizes modest stock markets establish a true handicap for the attraction of the investors eager for earnings. This instability of the savings remains the particular constraint for the financing of African economies in general.

When it comes to the applicability of the modern tools of the finance, we can sustain that the CAPM was unsuccessfully applied; that puts, in concern, the investors of this financial place who, should normally, in this context of financializing world, use modern universal tools to manage their portofolios.

The non-validity of this model on this market makes complex the yield's forecast for the investors who, will have to turn their gaze to pale imitations in order to manage properly their assets.

Besides, the risk premiums of this stock exchange not being significantly different from zero, it is about to know if this statistical non-significance is either due to the disappointing performance of the stocks or to other factors. For that purpose, it is necessary to note that this result can be due to the particularity of the emerging markets' structure, which according to some investors, present high risks levels for a lesser yield in comparison with the developed markets. Moreover, this result is due to the low level of liquidity and sophistication of emerging markets as that of Nairobi.

Conclusion

This study, by trying to analyze the validity of a modern finance tool (the CAPM) on an African market allowed us to make a number of reports.

The first report is concerning the nature of the stocks. On this matter, our research allowed us to highlight the fact that the stocks on the Nairobi's market have a low performance and a very low liquidity.

Thus it was noticed that the underlying fundamental hypotheses in the market model with the data of the Nairobi's stock exchange are not decisive. We noticed that on a 0.05 degree, non-normality was an important problem for numerous stocks in the same way as the non-specification with MCO Model valuers being biased and not suitable. There is not either significant linear correlation, though the beta's stability tests highlight a big temporal instability.

The market models is maybe not valid and even less for the periods of instability and speculation which occurs particularly in emerging markets.

Finally, our results revealed that there is no significant statistical relation between profitability and the beta, which is against the CAPM. Indeed the systematic risk would be capable of explaining the yields on the stocks only by 2.6 %.

Does the CAPM establish only a purely theoretical model without real practical application? Such a conclusion would be extreme.

On the other hand, the results of the present work underline that the use of the beta obtained in the conditions of this research (sample, frequency of daily calculation, market portofolio, hypothesis of temporal behavior of variables) to make choices of investment, to estimate the performance of the asset managers or estimate the cost of capital would lead to erroneous decision-making because of the absence of relation between the risks and the yields.

Appendices

Appendix 1: Statistics of share prices on the Nairobi's stock exchange.

Chart n°1: yields per stock

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	KN_ARM01	KN_BAM01	KN_BAT01	KN_BAU01	KN_BBK01	KN_BBO01	KN_BOC01
Mean	0.000554	0.000585	0.000878	-0.000653	0.000480	-0.000424	0.000310
Median	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Maximum	0.287682	0.745594	0.274845	0.099789	0.230815	0.172752	0.438255
Minimum	-0.405465	-0.723453	-0.415828	-0.532374	-0.233226	-0.211309	-0.438255
Std. Dev.	0.036387	0.037032	0.029066	0.018141	0.021104	0.016090	0.022048
Skewness	-1.265673	-0.066719	-2.073376	-18.12309	-0.556416	-2.727496	0.084859
Kurtosis	25.05385	216.3839	69.93598	512.0584	38.39368	60.31471	214.6269
Jarque-Bera	30737.16	2840103.	280539.1	16245835	78215.19	206756.5	2793526.
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1497	1497	1497	1497	1497	1497	1497

	KN_CAG01	KN_CAR01	KN_CBE01	KN_CFC01	KN_CMC01	KN_CTR01	KN_DTK01
Mean	-0.000482	0.000334	0.000709	0.000322	0.000518	-0.000319	0.000282
Median	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Maximum	0.636866	0.476924	0.799757	0.597837	0.403822	0.784119	0.371564
Minimum	-0.612295	-0.494019	-0.305382	-0.162519	-0.289466	-0.644357	-0.346871
Std. Dev.	0.027054	0.027093	0.035664	0.023751	0.027458	0.034994	0.025269
Skewness	-1.976949	-0.171751	7.812266	10.31217	2.970141	2.906305	-0.025065
Kurtosis	428.1967	154.7014	188.7453	277.3715	79.67279	313.4958	63.99702
Jarque-Bera	11277891	1435462.	2167247.	4722105.	368886.0	6015533.	232074.8
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1497	1497	1497	1497	1497	1497	1497

	KN_DUN01	KN_EAC01	KN_EAP01	KN_EGA01	KN_EPT01	KN_EXP01	KN_FIR01
Mean	-0.001583	-0.000585	-0.001090	-0.000567	0.000378	-0.001179	-0.000529
Median	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Maximum	1.576432	2.280924	0.471509	0.217723	0.530628	0.202941	0.493658
Minimum	-1.602749	-2.324726	-1.064711	-0.571450	-0.798508	-0.619039	-0.506561
Std. Dev.	0.076351	0.089168	0.037344	0.018043	0.035130	0.021957	0.030612
Skewness	-4.696071	-0.503485	-16.46420	-20.09338	-5.518331	-15.64817	-0.618088
Kurtosis	368.6430	596.7231	487.0766	695.1308	224.8131	435.3254	107.6738
Jarque-Bera	8344716.	21987697	14683976	29981170	3076513.	11719311	683513.6
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1497	1497	1497	1497	1497	1497	1497

	KN_HFC01	KN_ICD01	KN_JUB01	KN_KAK01	KN_KAP01	KN_KBL01	KN_KCB01
Mean	-0.000212	0.000396	0.000237	-0.001023	0.000271	0.001312	-0.000386
Median	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Maximum	0.422857	1.861324	0.201422	0.145182	0.145954	0.127833	0.448694
Minimum	-0.405465	-1.888680	-0.271153	-0.361700	-0.314811	-0.174991	-0.439032
Std. Dev.	0.038008	0.072193	0.020903	0.022401	0.011854	0.019937	0.037107
Skewness	-0.122697	-0.513126	-0.778863	-4.303328	-7.027802	-0.472334	0.675329
Kurtosis	33.68705	609.1244	34.90016	70.95796	401.5013	17.34628	50.24087
Jarque-Bera	58741.98	22915814	63625.42	292685.9	9917676.	12893.43	139316.0
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Observations	1497	1497	1497	1497	1497	1497	1497

	KN_KEL01	KN_KOR01	KN_KPL01	KN_LIM01	KN_MAR01	KN_NBK01	KN_NIC01
Mean	0.001424	-0.000424	-0.000805	0.000304	-0.001028	-7.95E-05	-0.000205
Median	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Maximum	0.270335	0.058269	0.772584	1.098597	1.317301	0.302281	1.779337
Minimum	-0.236401	-0.693147	-0.748043	-0.485508	-1.299283	-0.398030	-1.779337
Std. Dev.	0.020150	0.017979	0.042029	0.031321	0.066736	0.040476	0.071593
Skewness	1.698332	-38.22296	0.648278	26.25269	-4.425250	-0.277401	-0.026123
Kurtosis	57.30743	1474.171	152.1546	1050.479	320.3184	16.15699	511.3803
Jarque-Bera	184682.0	1.35E+08	1387767.	68610589	6285484.	10816.71	16120853
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1497	1497	1497	1497	1497	1497	1497

	KN_NMG01	KN_PAN01	KN_SAS01	KN_SCB01	KN_SNG01	KN_TOT01	KN_TPS01
Mean	0.000188	-0.000394	-0.000684	0.001005	-0.000463	-7.74E-05	0.000411
Median	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Maximum	1.442109	0.423814	2.181632	0.862706	2.639057	0.944855	0.890973
Minimum	-1.420448	-0.550046	-2.181632	-0.871839	-2.667228	-1.032708	-0.864997
Std. Dev.	0.069142	0.030603	0.082063	0.039795	0.126801	0.047698	0.038477
Skewness	-2.292585	-2.904346	0.032916	0.467896	-0.475631	-1.344780	0.437723
Kurtosis	291.1597	140.7506	668.3294	314.9135	299.7787	256.5381	365.4357
Jarque-Bera	5180684.	1185685.	27611122	6068522.	5493897.	4010014.	8193606.
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1497	1497	1497	1497	1497	1497	1497

	KN_UCH01	KN_UNG01	KN_VIP01	MARKET
Mean	-0.000347	-0.000233	-0.000392	0.001610
Median	0.000000	0.000000	0.000000	0.000000
Maximum	0.548898	1.791698	0.318454	0.628299
Minimum	-1.040648	-1.609438	-0.277632	-0.388616
Std. Dev.	0.049473	0.090440	0.036032	0.020760
Skewness	-6.001794	0.044124	0.176649	14.11547
Kurtosis	171.9085	211.9674	20.14281	643.3768
Jarque-Bera	1788552.	2721934.	18338.30	25645721
Probability	0.000000	0.000000	0.000000	0.000000
Observations	1497	1496	1497	1498

Source: computed from the data of the stock and monetary market

Appendix 2: test on the violation of the fundamental hypotheses of the market model.
Chart n°3: Results of the Ramsey's specification test

Codes	N	F-stat	Prob	LR (ratio of similarity)		Prob
KN_ARM01	1497	0.103529	0.747680	0.103733		0.747395
KN_BAM01	1497	0.105749	0.745082	0.105958		0.744794
KN_BAT01	1497	0.124718	0.724023	0.124963		0.723713
KN_BAU01	1497	1.245426	0.264607	1.247407		0.264048
KN_BBK01	1497	0.298208	0.585089	0.298777		0.584650

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KN_BBO01	1497	0.079020	0.778669	0.079176		0.778417
KN_BOC01	1497	0.135092	0.713261	0.135358		0.712940
KN_CAG01	1497	0.012463	0.911125	0.012488		0.911022
KN_CAR01	1497	0.711001	0.399247	0.712259		0.398695
KN_CBE01	1497	0.015242	0.901760	0.015273		0.901645
KN_CFC01	1497	0.232557	0.629705	0.233006		0.629304
KN_CMC01	1497	0.007109	0.932815	0.007124		0.932737
KN_CTR01	1497	0.065830	0.797543	0.065961		0.797311
KN_DTK01	1497	1.037907	0.308474	1.039630		0.307908
KN_DUN01	1497	0.087680	0.767189	0.087853		0.766924
KN_EAC01	1497	0.001304	0.971201	0.001306		0.971167
KN_EAP01	1497	2.06E-05	0.996383	2.06E-05		0.996379
KN_EGA01	1497	0.123936	0.724854	0.124180		0.724545
KN_EPT01	1497	0.118146	0.731103	0.118378		0.730800
KN_EXP01	1497	2.488193	0.114915	2.491116		0.114491
KN_FIR01	1497	1.580583	0.208873	1.582920		0.208341
KN_HFC01	1497	0.085349	0.770217	0.085517		0.769955
KN_ICD01	1497	4.28E-05	0.994783	4.28E-05		0.994777
KN_JUB01	1497	6.177831	0.013045	6.177473		0.012939
KN_KAK01	1497	1.786768	0.181524	1.789286		0.181013
KN_KAP01	1497	0.000439	0.983288	0.000440		0.983268
KN_KBL01	1497	0.056734	0.811768	0.056846		0.811551
KN_KCB01	1497	0.170588	0.679649	0.170921		0.679295
KN_KEL01	1497	0.082221	0.774349	0.082384		0.774092
KN_KOR01	1497	0.064642	0.799340	0.064770		0.799110
KN_KPL01	1497	0.115758	0.733729	0.115986		0.733429
KN_LIM01	1497	0.084021	0.771960	0.084188		0.771701
KN_MAR01	1497	0.049540	0.823896	0.049639		0.823693
KN_NBK01	1497	0.508227	0.476019	0.509161		0.475502
KN_NIC01	1497	0.061535	0.804121	0.061657		0.803896
KN_NMG01	1497	0.011709	0.913846	0.011732		0.913745
KN_PAN01	1497	0.474000	0.491260	0.474876		0.490752
KN_SAS01	1497	0.013182	0.908609	0.013208		0.908502
KN_SCB01	1497	0.267489	0.605097	0.268003		0.604675
KN_SNG01	1497	0.004726	0.004726	0.004736		0.945135
KN_TOT01	1497	0.059124	0.807920	0.059241		0.807699
KN_TPS01	1497	0.000624	0.980067	0.000626		0.980044
KN_UCH01	1497	0.006466	0.935922	0.006479		0.935847
KN_UNG01	1497	0.001421	0.969939	0.001423		0.969904
KN_VIP01	1497	2.338408	0.126430	2.341272		0.125987

Chart n°4: analysis of the heteroscedasticity of the actions

Codes	N	F-stat	Prob	R^2	NR^2	Prob-R^2
KN_ARM01	1497	0.083470	0.919923	0.000111	0.167257	0.919773
KN_BAM01	1497	0.003608	0.996399	0.000004	0.007230	0.996392
KN_BAT01	1497	0.034859	0.965742	0.000046	0.069855	0.965675
KN_BAU01	1497	0.150961	0.859894	0.000202	0.302467	0.859647
KN_BBK01	1497	0.010410	0.989644	0.000013	0.020862	0.989623

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KN_BBO01	1497	0.034658	0.965936	0.000046	0.069453	0.965870
KN_BOC01	1497	0.003563	0.996443	0.000004	0.007141	0.996436
KN_CAG01	1497	0.019752	0.980442	0.000026	0.039582	0.980403
KN_CAR01	1497	0.173166	0.841015	0.000231	0.346946	0.840740
Kn_CBE01	1497	0.071269	0.931214	0.000095	0.142811	0.931084
KN_CFC01	1497	0.004115	0.995894	0.000005	0.008246	0.995885
KN_CMC01	1497	0.016644	0.983494	0.000022	0.033353	0.983462
Kn_CTR01	1497	0.003063	0.996942	0.000004	0.006138	0.996936
KN_DTK01	1497	0.005534	0.994481	0.000007	0.011091	0.994470
KN_DUN01	1497	0.004278	0.995731	0.000005	0.008574	0.008574
KN_EAC01	1497	0.068617	0.933687	0.000009	0.137497	0.933562
KN_EAP01	1497	0.002332	0.997671	0.000003	0.004674	0.997666
KN_EGA01	1497	0.363496	0.695303	0.000486	0.728097	0.694858
KN_EPT01	1497	0.003532	0.996474	0.000004	0.007078	0.996467
KN_EXP01	1497	0.004797	0.995214	0.000006	0.009614	0.995204
KN_FIR01	1497	0.001292	0.998709	0.000001	0.002590	0.998706
KN_HFC01	1497	0.126469	0.881211	0.000169	0.253403	0.880997
KN_ICD01	1497	0.002606	0.997397	0.000003	0.005222	0.997392
KN_JUB01	1497	0.068195	0.934082	0.000091	0.136651	0.933957
KN_KAK01	1497	0.001437	0.998564	0.000001	0.002880	0.998561
KN_KAP01	1497	0.024230	0.976061	0.000032	0.048557	0.976014
KN_KBL01	1497	0.207909	0.812305	0.000278	0.416537	0.811989
KN_KCB01	1497	0.031582	0.968912	0.000042	0.063288	0.968852
KN_KEL01	1497	0.058763	0.942932	0.000078	0.117753	0.942823
KN_KOR01	1497	0.098062	0.906599	0.000131	0.196491	0.906426
KN_KPL01	1497	0.104763	0.900545	0.000140	0.209917	0.900362
KN_LIM01	1497	0.051390	0.949910	0.000068	0.102980	0.949813
KN_MAR01	1497	0.039426	0.961342	0.000052	0.079006	0.961267
KN_NBK01	1497	0.040212	0.960587	0.000053	0.080581	0.960511
KN_NIC01	1497	0.043802	0.957145	0.000058	0.087774	0.957062
KN_NMG01	1497	0.342548	0.710015	0.000458	0.686157	0.709583
KN_PAN01	1497	0.007878	0.992153	0.000010	0.015787	0.992138
KN_SAS01	1497	0.001705	0.998296	0.000002	0.003417	0.998293
KN_SCB01	1497	0.020125	0.980077	0.000026	0.040329	0.980038
KN_SNG01	1497	0.021336	0.978890	0.000028	0.042757	0.978848
KN_TOT01	1497	0.032622	0.967905	0.000043	0.065372	0.967843
KN_TPS01	1497	0.012773	0.987308	0.000017	0.025597	0.987283
KN_UCH01	1497	0.085074	0.918449	0.000113	0.170470	0.918297
KN_UNG01	1497	0.025968	0.974366	0.000034	0.052039	0.974316
KN_VIP01	1497	0.105665	0.899733	0.000141	0.211725	0.899548

Source: computed from the data of the stock-exchange and monetary markets.

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