

Zaimi, Wiam

Article

An empirical analysis of a stock market index of a developing country: Case of the main index of the Casablanca Stock Exchange MASI

Global Business & Finance Review (GBFR)

Provided in Cooperation with:

People & Global Business Association (P&GBA), Seoul

Suggested Citation: Zaimi, Wiam (2022) : An empirical analysis of a stock market index of a developing country: Case of the main index of the Casablanca Stock Exchange MASI, Global Business & Finance Review (GBFR), ISSN 2384-1648, People & Global Business Association (P&GBA), Seoul, Vol. 27, Iss. 4, pp. 1-16,
<https://doi.org/10.17549/gbfr.2022.27.4.1>

This Version is available at:

<https://hdl.handle.net/10419/305854>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc/4.0/>

An Empirical Analysis Of A Stock Market Index Of A Developing Country: Case Of The Main Index Of The Casablanca Stock Exchange MASI

Wiam Zaimi[†]

PhD-Student in Organizational Management Science Lab, National School of business and Management, Ibn Tofail University, Morocco

ABSTRACT

Purpose: Managing stock market risk and making an optimal investment decision in a stock market requires studying the dynamics of this market and analyzing the fluctuations of its benchmark index in order to avoid heavy damage in the event of crises. This paper aims to study and analyze the fluctuations of the main index of the Casablanca Stock Exchange "MASI" to explore its efficiency and stability in the normal financial context (especially before the recent pandemic crisis).

Design/methodology/approach: To carry out this study, two methods are proposed, the first one, how evolves this index over time depending on some random data generation processes widely used for stock prices: A Random Walk with a drift $RW(\alpha)$ and an autoregressive process of order 1 $AR(1)$. Based on the actual MASI returns series used (2007-2018), we estimate each equation parameter according to the process chosen to generate the artificial MASI returns series to know the most relevant data generation process in the case of The Moroccan financial market. The second method focuses on the technique of "simple moving average" as a method of stock prices fluctuation analysis to make its investment decision, choosing the proper order on the same series.

Findings: The results and findings of our econometric study show, in the first method, that either the $RW(\alpha)$ or the $AR(1)$ process cannot adequately model MASI fluctuation. However, the results of the second method affirm the utility of the simple moving average to identify trends, their strength and buy / sell signals, using some techniques known in this field, in order to make decisions and draw interpretations in investment terms and risk management, which can prove that the market is less efficient and stable.

Research limitations/implications: An important implication of this study is the need to explore the efficient models to describe the MASI return series.

Originality/value: This study offers empirical evidence in relation to the estimation of the econometric model to describe MASI and how to make adequate investment decisions in the Moroccan stock market. Moreover, contributes to future research to find other more appropriate models.

Keywords: MASI index, Financial risk management, Stochastic process of data generation, Simple Moving Average.

I. Introduction

Despite the technological backwardness of African

financial markets compared to other continents, in 2018, the Casablanca Stock Exchange is ranked the seventh stock exchange in Africa in terms of performance (Yanmi, 2019). and it closed the top 10 in terms of free float, or 27% of total market capitalization (Agence Ecofin, 2018). It has a capitalization of 51 billion Euro. The Casablanca Stock Exchange has

Received: Mar. 15, 2022; Revised: May. 12, 2022; Accepted: Jun. 23, 2022

[†] Wiam Zaimi

E-mail: zaimi.wiam@uit.ac.ma

75 listed companies and 17 companies (CRI, 2017).

After the three successive reforms (1967, 1986, and 1993) which the Casablanca stock exchange has known, it has become more and more attractive by dint of new technologies and electronic quotes. And at the beginning of 2008, the Casablanca Stock Exchange switched to the quotation system « NCC V900 » which is the same system used by Euronext (The Casablanca Stock Exchange, 2021).

Like any stock exchange, the Casablanca stock exchange has a benchmark indicator, this one is named MASI (Moroccan All Shares Index) created in 2002, replacing IGB (Indice Général Boursier). It is a broad-based index comprising all shares and it is measured in points and percentage.

In the era of financial markets digitalization, the Casablanca Stock Exchange has become increasingly competitive in terms of massive transactions management and electronic trading as well as in the rapid expansion of high-frequency trading (HFT).

Nevertheless, this development cannot only reduce the security of operations, in fact, it represents a major challenge in the analysis and modeling of financial risks.

In this context, the purpose of this article is to study and analyze the fluctuations of the MASI by two empirical methods, the first consists in using two random processes of data generation (A random walk with derivative RW(a) and an autoregressive process of order one (AR (1))), the second method is to use the Simple Moving Average. This allows, to know the evolution, the nature of the dynamics and the appropriate data generation model of the benchmark indicator of the Moroccan financial market. Also how to make an optimal investment decision. Therefore, to get informed whether this market is efficient and/or stable.

Before starting any empirical study, an economic analysis is necessary to express the motivation of our paper. This study aims at exploring the degree of reliability of the fluctuation of the stock exchange index in adequacy with the economic fluctuation of the sectors represented by publicly traded company displayed by this index. In this optic, we wonder if the MASI

variations are summarized by the economic added value and the adequate model that allows us to accompany the economic fluctuations of the Moroccan publicly traded company

In view that the empirical studies elaborated on the Moroccan stock market are limited, and that this market deserves to be highlighted by scientific research, given that it belongs to the emerging markets of the world and to the top 10 of Africa. Our contribution will be to reuse the models RW (α), the AR (1) and the simple moving average as tools for analyzing and modeling Moroccan stock returns on a recent database, more or less long and in normal conditions; before COVID'19 crises (2007-2018) in order to ensure the efficiency and stability of this market.

The next section is devoted to the literature review. The third section describes the MASI price series and presents an economic analysis of it. The fourth section outlines the methodology of the two random processes used. The fifth section describes the usefulness of the simple moving average as a tool for analyzing stock market fluctuations, and then its methodology for each order chosen on the MASI series. Section VI presents the empirical results. In section VII, we find a general conclusion.

II. Literature Reviews

The analysis and modeling of stock markets has long been a fertile field for international and national research. However, the majority of this research has been done on the American and European stock markets, while studies on emerging markets and especially on Africa are generally too moderate hence the need to stimulate this kind of research in emerging countries. It is true that these markets remain small, they have a low level of transactions, and operations compared to the developed markets of America and Europe. Moreover, that there is not enough information to draw solid conclusions.

However, some hypotheses of the efficiency of

African markets have been tested such as that of Graham & al. (2002), in which they are assumed that the stock indices of eight African markets: South Africa (large size), Egypt, Kenya, Morocco, Nigeria, Zimbabwe (medium size), Botswana and Mauritius (small size), were following a random walk, using the multiple VR test. They observed that only the South African market followed a random walk.

Adjasi (2004) was able to verify a positive asymmetry in the volatility of stock returns when he modeled the returns of GSE using EGARCH (1, 2) on average.

Again, Jeffris and Smith (2005) examined the efficiency of African markets by the GARCH approach, using the test of evolving Efficiency (TEE) for the years 1990-2001. This test showed that Throughout this period, the Johannesburg stock exchange was weak, while the other three African markets (Egypt, Morocco, Nigeria) became efficient until the end of the period, unlike the markets of Kenya and Zimbabwe showed no tendency to weak-form efficiency.

Lagoarde-Segot and Lucey (2006), studied the efficiency of the Middle East and MENA stock markets by first aggregating the results of random walk tests and technical analysis of trading into one single efficiency index, in order to use an ordered multinomial logistic regression to explain the extent of the efficiency of the weak form in each stock market.

Alagidede (2008) also used the GARCH model to study the behavior of stock returns on the major African markets (South Africa, Egypt, Morocco, Nigeria, Kenya and Tunisia), his results indicate that the efficiency of the weak form was rejected for all markets.

In addition, Nwosu & al (2013) examined the weak form of market efficiency of five exchanges: four African markets and one developed market. They analyzed the weekly returns of its stock index: EGX30, NSE 20, NSE All Share Index, FTSE-JSE All Sare Index, S&P 500 for the period 1998-2008, by various methods (autocorrelation test, unit test, linear and non-linear models). Their results show that African markets do not not behave in a manner compatible with the weak form of market efficiency (and therefore the rejection of the random walk hypothesis).

Recently, Joel & al (2018) reexamined the effectiveness of the weak form of five stock markets (South Africa, Nigeria, Egypt, Ghana and Mauritius) via the new nonlinear fourier unit root test advanced by Enders and Lee (2005) to assess the effect of non-linearity and the fluidity of trade on the efficiency of the market during the period 2000-2003. This test made it possible to conclude as results the acceptance of RWH for South Africa, Nigeria and Egypt and its rejection for Ghana and Mauritius.

With regard to local research, the empirical study on the Moroccan stock markets is a topic rarely addressed. Indeed, Moulay El Mehdi and Amal (2014) have proposed a model of the performance of the Moroccan stock market, from two methods "ARIMA-Box-JENKINS" and GARCH. The MASI index was analyzed over a period (2009-2012) to obtain a result that favors the GHARCH (1, 1) model due to the approximation these values at actual realized values and its taking into account of the volatility that characterizes the MASI index.

Along the same lines, Mohamed Saber H. and Mohamed B. (2016) modeled the MASI time series (2000-2016) by the ARIMA model, but the results were unfavorable, which allows the authors to propose a new paradigm of modern finance: the impact of psychology on the behavior of the investor in his decision-making.

For the same reason, Coffie (2017) from the University of Ghana took the initiative to study the effect of the volatility of stock returns on the Casablanca stock market and the Regional Stock Exchange (BVRM). For this, he compared the different distribution densities forecasting methodologies of three generalized autoregressive conditional heteroskedasticity models: The symmetric GARCH, symmetric Glosten Jagannathan and Runkle (GTR) version of GARCH (GTR-GARCH) and Exponential GARCH methodology.

The weight and importance of stochastic models in finance have prompted digital finance researchers to test the random walk model on crypto-currencies, as in the case of Aggarwal's (2019) paper, "Do bitcoins follow a random walk?" This study seeks to contribute to the existing literature by examining bitcoin returns

under a financial asset purview. Its findings assert that there is strong evidence of market inefficiency characterized by the absence of a random walk model.

Also in the same vein, Palamalai & All (2021) opined another test of the random walk hypothesis for cryptocurrencies under the title "Testing the random walk hypothesis for leading cryptocurrencies". In this study, the authors examined the weak form efficiency of the top ten crypto-currencies using non-parametric and parametric random walk test methods. Their results do not support the random walk hypothesis, validating the inefficiency of weak form for daily crypto-currency returns. This can be attributed to the presence of asymmetric volatility clusters. According to these authors, this study has important implications for portfolio managers, market participants and regulators of leading cryptocurrency markets.

Still remaining in international research, the random walk hypothesis was also adopted by Enkhzul & Jun (2021) in their paper "Do Short Selling and Margin Trading Affect Price Randomness?", to investigate the effect of short selling and margin trading on the randomness of stock prices in the Korean stock market, by employing the Lo and Mackinly variance ratio test. Their results indicate that short selling makes stock prices more predictable, while margin trading makes stock prices more random.

We close this part with the article that gave us the inspiration to start this study under the title "Bootstrap Analysis of the Nikkei 225" (Kung & al, 2012). This study aimed to determine whether or not Nikkei returns are acceptable with those generated by four random processes widely used for stock prices. their results indicate that the random walk with drift and the GARCH(1,1) process are inadequate to describe the series of Nikkei returns, while the most appropriate model for pricing Nikkei 225 index options uses the GARCH(1, 1) -M to characterize the dynamics of the Nikkei return series.

III. Description and Economic Analysis of MASI Data

A. The MASI Data Series

The data used are the daily closing prices of the MASI in a normal context (see Figure 1) from January 2nd, 2007 to December 31st, 2018, a total of 2,982 observations. They were retrieved from the Casablanca Stock Exchange database (2019).



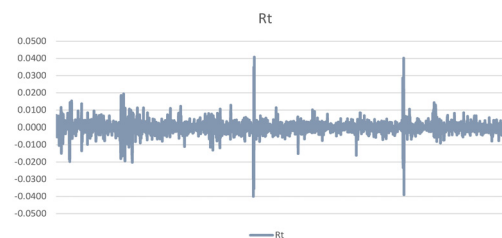
Source: the Casablanca Stock Exchange website

Figure 1. Daily MASI Closing Prices from January 2nd, 2007 to December 31st, 2018

We compute the daily return as the natural log difference of the MASI prices. That is,

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

Where P_{t-1} and P_t are the closing prices of the MASI on respectively day t-1 and t, while R_t is the return on day t.



Source: established by the author using data from the Casablanca Stock Exchange website

Figure 2. Daily MASI Returns from January 2nd, 2007 to December 31st, 2018

The daily MASI returns curve shows outliers, two of which have a large erratic variation almost of the same value (0.04), one is dated 26/03/2012, and the other on 04/03/2016. Another irregular movement is detected in mid-September 2008 (with a value of 0.0185).

B. An Economic Analysis of MASI

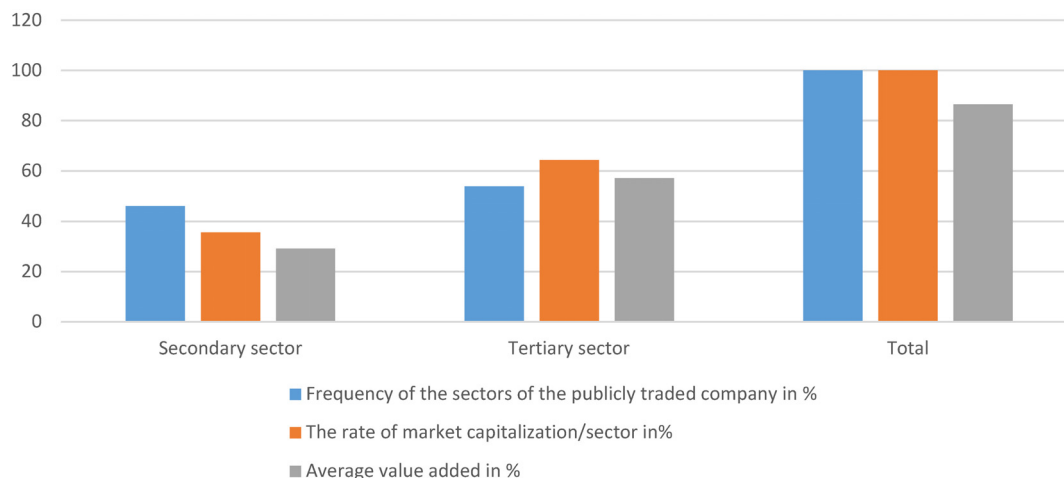
We know that MASI, as indicated by its name (Moroccan All Share Index), includes the stock market variations of all the publicly traded company in all the sectors of activity. For this reason, we opt for a comparison between three variables: the percentage frequency of the sectors of the publicly traded company, the rate of market capitalization by sector and the added value of each of these sectors in %. To know if the variations of MASI accompany the evolution of the added value between the years 2007 and 2017

in each economic sector.

During the period under study, the MASI index summarizes the stock market variations of 67 companies included in two major economic sectors:

- Secondary sector, which includes all activities consisting of a more or less elaborate transformation of raw materials (manufacturing industries, construction, electricity and water...)
- The tertiary sector, which is composed of mainly commercial activities (trade, transport, post and telecommunications, etc.) (Fourastié, 2019)

The Figure 3 presents a histogram including the percentage frequency of publicly traded company in each economic sector, the share of market capitalization of each sector and the average value added per sector as a percentage of total value added in that period.



Source: established by the author, using data from:
<https://lematin.ma/bourse-de-casablanca/cours-valeurs.html#secteur1> https://www.finances.gov.ma/Publication/depf/2019/Tableau_de_bord_sectoriel_janvier%202019.pdf

Figure 3. Fig. 4. Sectorial distribution of the frequency, market, capitalization and the added value of Moroccan publicly traded company

This economic study allowed us to conclude:

- The absence of the primary sector in the Casablanca Stock Exchange

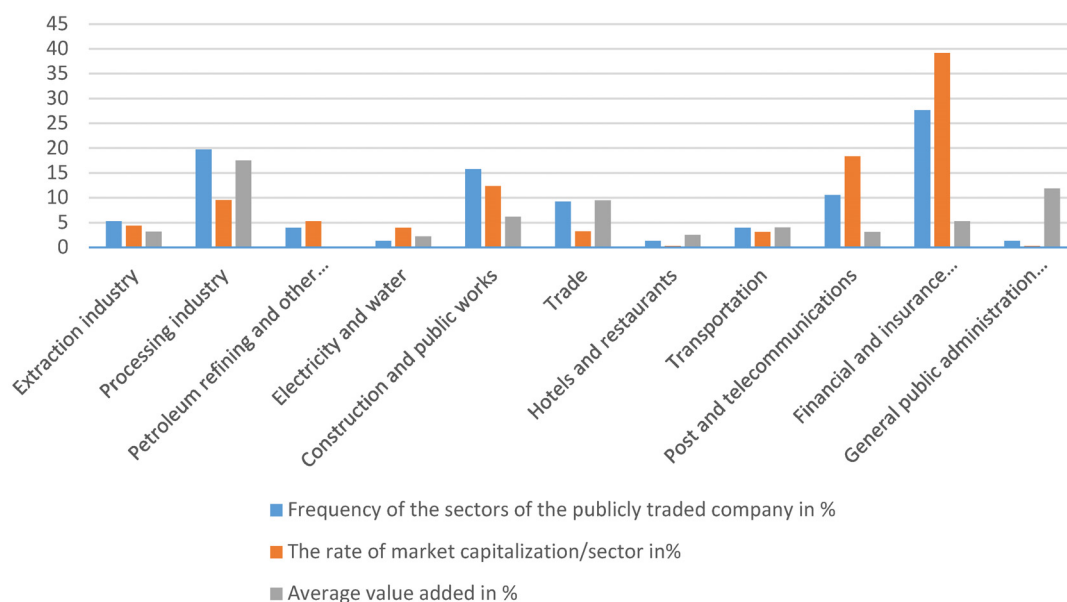
- An approximate equality of the percentage of the three variables (53.95%, 64.45%, 57.20%) at the level of the tertiary sector, which shows

the performance of the sector in financial and economic terms

- On the other hand, the secondary sector shows less intervention in terms of market capitalization compared to the tertiary sector (a share of 35.55), even if they have almost the same frequency

of publicly traded company (46.05). On the other side, a moderate share of added value.

Figure 4 shows the same data as the previous figure, except that this histogram allows us to distinguish each sectoral activity separately.



Source: established by the author, using data from:
<https://lematin.ma/bourse-de-casablanca/cours-valeurs.html#secteur1>
https://www.finances.gov.ma/Publication/depf/2019/Tableau_de_bord_sectoriel_janvier%202019.pdf

Figure 4. Distribution of frequency, market, capitalization and value added of listed Moroccan companies by sectoral activity

By this figure, we can understand:

- Despite the large share of market capitalization of financial and insurance activities in total activity in Morocco (39.16), however, the portion of this activity remains low in terms of value added (5.3%).
- The same is true for the activities of post and telecommunications, construction and public works, oil refining and other energy products.
- In contrast to the above activities, the activities of general public administration and social security, trade and transformation industry are performing according to the value added more than the market capitalization.

- The rest of the activities are average from the point of view of any variable under study

IV. The Return Generating Processes and Methodology

A. The random walk process RW (α)

According to Jovanovic, F. (2009): "A random walk, $\{X_t, t \in T\}$, is a stochastic process with independent and stationary increments in discrete time

such that $S_0 = 0$ and $S_n = \sum_{t=1}^n X_t$, where the X_t are independent and equidistributed. Among other things, we have $E(S_n) = 0$ and $Var(S_n) = n$. It is thus a series of random variables indexed by t , which, for stock prices, represents time. According to this process, the evolution of the price of an asset, P_t is of the form $P_{t+1} = P_t + \epsilon_{t+1}$, where $\epsilon = \{\epsilon_t ; t \in \mathbb{N}\}$ is white noise.

More generally known is the continuous-time version of the random walk, Brownian motion-or Wiener process-which is a continuous trajectory, independently increasing, stationary process such that $S_t = S_0 + \sigma \mathbb{W}_t$, where \mathbb{W}_t is a standard Brownian motion, with $\mathbb{W}_0 = 0$, $E(\mathbb{W}_1) = 0$ and $E(\mathbb{W}_1^2) = 1$. Indeed, Brownian motion is a continuous stochastic process that allows us to model random behavior as a function of time. Therefore, we can say that a stochastic process $(\mathbb{W}_t, t \geq 0)$ is a Brownian motion of volatility σ if:

1. $\mathbb{W}_0 = 0$;
2. \mathbb{W}_t follows a normal distribution $N(0; \sigma\sqrt{t})$;
3. \mathbb{W}_t process with stationary increments: for $s < t$, the increment $\mathbb{W}_t - \mathbb{W}_s$ depends only on the value of $t-s$ ie $\mathbb{W}_t - \mathbb{W}_s$ follows a normal distribution $N(0; \sigma\sqrt{t-s})$;
4. \mathbb{W}_t is an independently increasing process: for any time sequence $t_1 < t_2 < \dots < t_n$, $\mathbb{W}_{t_2} - \mathbb{W}_{t_1}$, $\mathbb{W}_{t_3} - \mathbb{W}_{t_2}$, $\mathbb{W}_{t_n} - \mathbb{W}_{t_{n-1}}$ are independent random variables.

The reasons behind choosing the random walk model are: firstly, this model covers a very important place in financial economics since it was started as the first theoretical work of this discipline (Jovanovic, 1863). Secondly, it still remains one of the current theoretical works by economists because it is based on the theory of informational efficiency developed between 1965 and 1976 by Fama (1965, 1970). This theory assumes and gives a representation of the dynamic evolution of prices balance of a free market. As such, the random walk model, which is based on informational efficiency theory, has played a leading role in the creation of financial economics as a scientific

discipline (Regnault, 1863).

Under this process, the evolution of the return of an asset, R_t is of the form $R_t = \alpha + \epsilon_t$, where ϵ_t is white noise.

As a methodology, the steps are as follow:

- a. Based on the actual MASI return series, we estimate the parameter of the random walk process equation, using the ordinary least squares method

$$R_t = \alpha + \epsilon_t$$

$$E(R_t) = \alpha + E(\epsilon_t)$$

We know that ϵ_t is white noise, so $E(R_t) = \alpha$

Meaning that $\hat{\alpha} = \bar{R}$

- b. we compute the residual as:

$$e_t = R_t - \hat{R}_t$$

- c. So for each j we compute:

$$R_j = \hat{\alpha} + e_j$$

(where $j = 1, 2, 3, \dots, N$) to generate the artificial MASI return series $RW(\alpha)$.

Then the artificial MASI return series generated by the process of the random walk is equivalent to the current series.

- d. We convert each artificial $RW(\alpha)$ MASI return series by the MASI price series using the equation:

$$R_t = (\log(P_t) - \log(P_{t-1})).$$

That is:

$$P_j = e^{(R_j)} * P_{j-1}$$

B. Autoregressive process of order 1 (AR(1))

The first order autoregressive process is also an

important stochastic process, because it belongs to the class of Markov process, which is widely applicable in the field of finance.

"Classical autoregressive processes driven by strong white noise were introduced by Box-Jenkins. Currently, models using autoregressive processes with dependent perturbations are widely used in various fields, particularly in econometrics and finance" (Marius 2019).

In this case, we propose that the autocorrelation of the process is equal to one step and it is described by:

$$R_t = \alpha + \beta R_{t-1} + \epsilon_t$$

With ϵ_t is white noise: $\epsilon_t \cong N(0; \sigma^2)$

As a methodology, the steps are as follow:

- a. Based on the actual MASI return series, we estimate the two parameters of the autoregressive process of order 1 equation by using the ordinary least squares method

$$E(\hat{R}_t) = \frac{\hat{\alpha}}{1 - \hat{\beta}}$$

$$V(\hat{R}_t) = \frac{\hat{\sigma}^2}{1 - \hat{\beta}^2}$$

- b. we compute the residual as

$$e_t = R_t - \hat{R}_t, \quad t = 1, 2, \dots, N \text{ and}$$

$$\hat{R}_t = \hat{\alpha} + \hat{\beta} R_{t-1}$$

Therefore, we obtain the series of residuals:

$$\{e_1, e_2, \dots, e_N\}.$$

- c. For each j , we randomly draw a residual with placement from the residual series and from

$$R_j = \hat{\alpha} + \hat{\beta} R_{j-1} + e_j, \quad (j: 1 \rightarrow N)$$

To generate the artificial MASI return series AR (1).

- d. We convert each artificial AR (1) MASI return series by the MASI price series using the equation:

$$R_t = \log(P_t) - \log(P_{t-1}).$$

$$\text{That is: } P_j = e^{(R_j)} * P_{j-1}$$

V. Analysis of the Fluctuation of the MASI Index by the Simple Moving Average

A. The Simple Moving Average as a Process of Analyzing Stock Market Fluctuations

The moving average is one of the most used technique in the field of analysis and stock market forecasting due to it being user friendly and easy to interpret. It reflects the average valuation of a stock price over a specified period.

The moving average allows to identify trends and their strengths, as well as to identify fluctuations of a stock market price or indicator, since it can get rid of background noise by smoothing out price variations, and therefore, it makes easier reading fluctuations and trends, resulting in quick interpretations and predictions (Bouteiller & Finck, 2007)

Thus, the moving average makes it possible to identify the buy / sell signals, by analyzing the positions and crossings of the moving average with the price or with another moving average (short-term moving average with another long-term or opposite) (Bouteiller & Finck, 2007)

Therefore, one of the motivation of this paper is to use the moving average as a tool for studying and analyzing the MASI fluctuations during the period 2007-2018 in order to take decision-making interpretations in terms of investment and risk management.

B. Methodology

The moving average used is an arithmetic moving

average, calculated over a chosen period (the order), which corresponds to the sum of the closing prices of the MASI index over this period divided by the number of days in this period, i.e. the following formula:

$$M_{t,n} = \frac{1}{n} \sum_{K=t-n+1}^t P_K$$

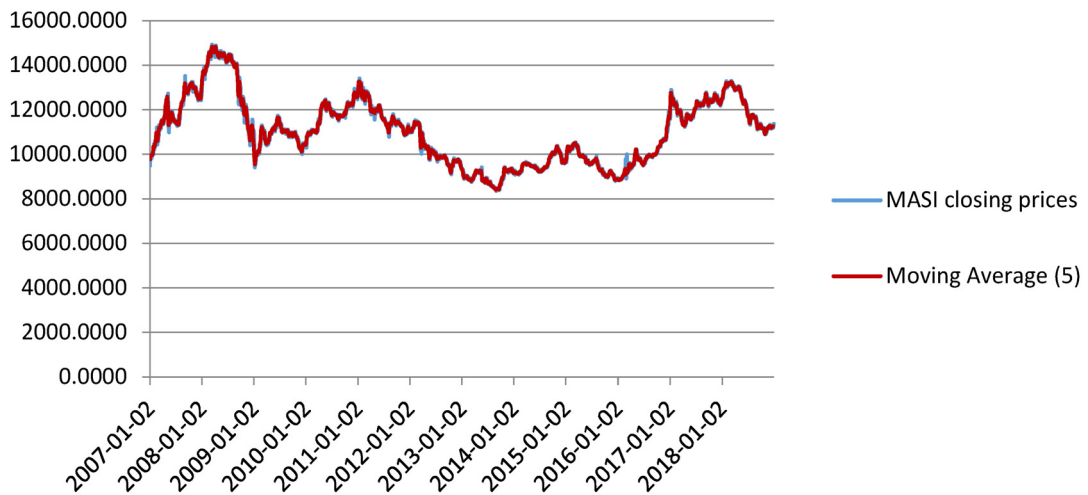
Where: P_K is the daily closing price of the MASI on day K , and n is the length of the period.

The choice of the length of the period is classic opted in mostly by financiers and investors in the field of stock market analysis and forecasting.

1. Simple moving average of order 5

It is a short-term moving average, which means one week of trading, calculated as follows:

$$M_{t,5} = \frac{1}{5} \sum_{K=t-4}^t P_K$$



Source: established by the author using data from the Casablanca Stock Exchange website

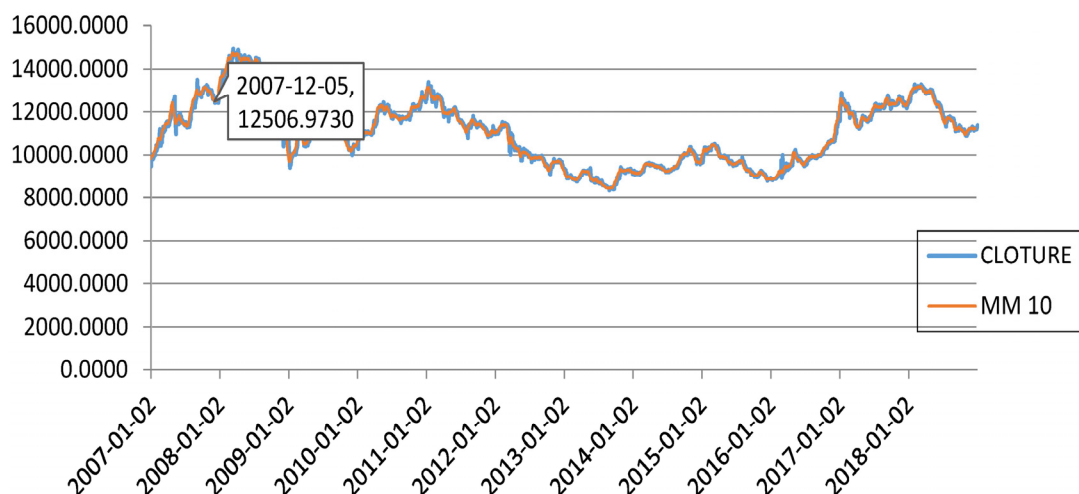
Figure 5. MASI curve and its Moving Average (5)

Both of the closing price and SMA (5) curve are approximately the same, so choosing the period of 5 does not clearly identify the trend.

2. Simple moving average of order 10

It is a short-term moving average, i.e. two weeks of trading, calculated as:

$$M_{t,10} = \frac{1}{10} \sum_{K=t-9}^t P_K$$



Source: established by the author using data from the Casablanca Stock Exchange website

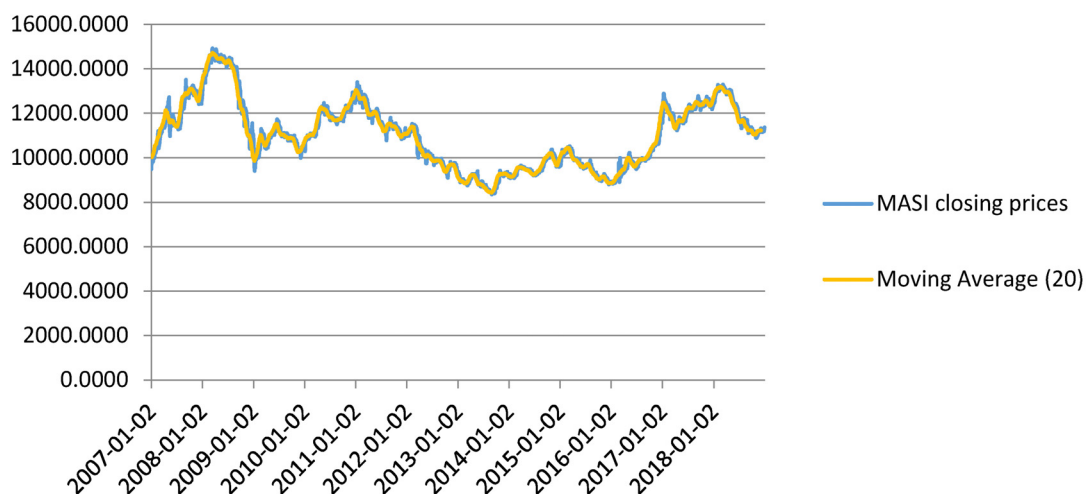
Figure 6. MASI curve and its Moving Average (10)

The SMA (10) curve passes in the vicinity of the closing prices curve. This SMA still eliminated some erratic variations.

3. Simple moving average of order 20

This is an medium-term moving average, i.e. one month of trading, calculated as follows:

$$M_{t,20} = \frac{1}{20} \sum_{K=t-19}^t P_K$$



Source: established by the author using data from the Casablanca Stock Exchange website

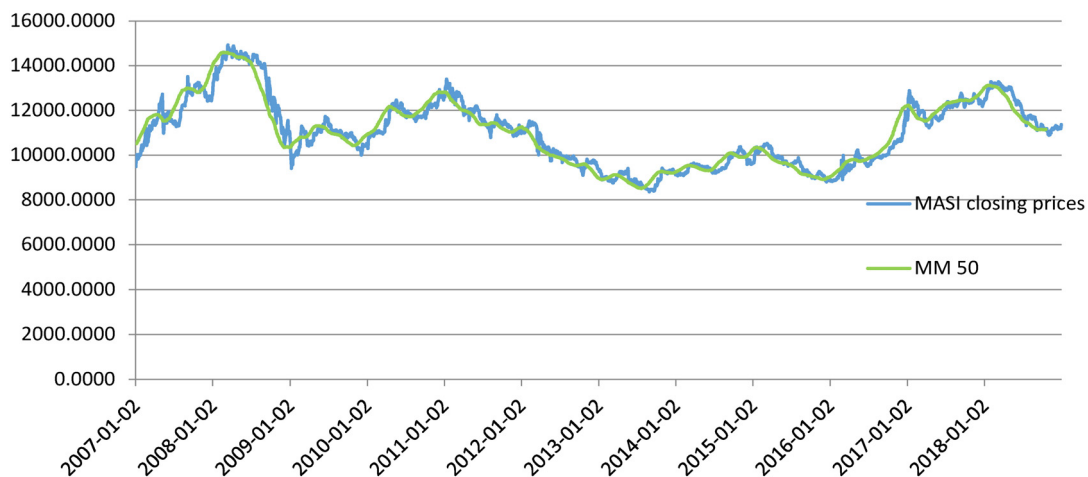
Figure 7. MASI curve and its Moving Average (20)

SMA (20) has almost the same smoothing as SMA (10) except that it eliminates even more irregular variations.

4. Simple moving average of order 50

This is a medium-term moving average, which means five weeks of trading, calculated as follows:

$$M_{t,50} = \frac{1}{50} \sum_{K=t-49}^t P_K$$



Source: established by the author using data from the Casablanca Stock Exchange website

Figure 8. MASI curve and its Moving Average (50)

The SMA (50) has a more or less strong effect on the curve. It can get rid of large background noise by smoothing many possible accidental deviations, therefore a clearer and easier reading trend. On the other hand, a long-term SMA does not display the averages around the limits throughout the debt period (loss of data).

C. Identification of Trends and Buy / Sell Signals

As already mentioned above, the moving average can identify trends and strengths, also it identifies the fluctuations of a stock market indicator, since it can get rid of the background noise by smoothing price fluctuations. Thus, it makes it possible to identify buy / sell signals, by analyzing the positions and crosses of the moving average with the price or with another

moving average (Bouteiller & Finck, 2007). Our task in this phase is to use the graphics of some already calculated moving averages to identify trends and signals, using some techniques widely used by financiers.

The results of some the most known techniques are represented in empirical results.

VI. Empirical Results

A. Results of the Modelisation with the RW(a) Process

To check if the MASI returns evolve as a function of RW(α), we first calculated the parameter α using the ordinary least squares method, we found: $\bar{R} = 0$ That is $\hat{\alpha} = 0$

Then we compute the residual as:

$$e_t = R_t - \hat{R}_t$$

and $\hat{R}_t = \hat{\alpha} = 0$
 that is: $e_t = R_t$

The Table 1 represents for the first 10 days, the series of real daily MASI returns, the estimated parameter of the process RW(α), the series of theoretical MASI returns, the series of residuals and the series of artificial MASI returns generated by this process.

Table 1. RW(a) Process Results

t	Closing (p_t)	R_t	$\hat{\alpha}$	e_t	R_j	P_j
1	9482,6299	0,0000	0	0,0000	0,0000	0,0000
2	9625,3799	0,0065	0	0,0065	0,0065	9544,3635
3	9780,2803	0,0069	0	0,0069	0,0069	9692,3486
4	9933,2900	0,0067	0	0,0067	0,0067	9846,4399
5	10023,4600	0,0039	0	0,0039	0,0039	9972,3503
6	9971,4102	-0,0023	0	-0,0023	-0,0023	10000,8218
7	9940,0098	-0,0014	0	-0,0014	-0,0014	9957,7610
8	9814,7695	-0,0055	0	-0,0055	-0,0055	9885,4235
9	9856,2197	0,0018	0	0,0018	0,0018	9832,7496
10	10006,8799	0,0066	0	0,0066	0,0066	9921,3699

Source: established by the author

B. Results of the Modelisation with the AR(1) Process

The AR (1) process aims to check if the MASI data is evolved by daily autocorrelations in the series of returns. If there is a positive autocorrelation, a higher (lower) return today will tend to be followed by a higher (lower) return the next day and if there is a negative autocorrelation, a higher (lower) return today will tend to be followed by a lower (higher) return on next day.

In our case, we are talking about a positive autocorrelation between the MASI returns since the autocorrelation parameter is positive, i.e.:

$$\hat{\alpha} = (1 - \hat{\beta}) \quad E(\hat{R}_t)$$

We have $E(\hat{R}_t) = 0$ that is $\hat{\alpha} = 0$

So, we obtain this equation

That is

$$\hat{R}_t = \hat{\beta} \hat{R}_{t-1} + e_t$$

$$\hat{\beta} = \frac{\frac{1}{N} \sum_{t=1}^N R_{t-1} \times R_t}{\frac{1}{N} \sum_{t=1}^N R_{t-1}^2}$$

In our case the estimate value of β is 0,09681.

The Table 2 represents for the first 10 days, the series of real daily MASI returns, the estimated parameters of the process AR (1), the series of theoretical MASI returns, the series of residuals and the series of artificial MASI returns generated by this process.

Table 2. AR(1) Process Results

t	Closing (p_t)	R_t	$\hat{\alpha}$	$\hat{\beta}$	\hat{R}_t	e_t	R_j	P_j
1	9482,6299	0,0000	0	9,68E-02		0,0000	0	0,0000
2	9625,3799	0,0065	0	9,68E-02		0,0000	0	9544,3637
3	9780,2803	0,0069	0	9,68E-02	0,000628255	0,0063	0,006933422	9692,3491
4	9933,2900	0,0067	0	9,68E-02	0,000671275	0,0061	0,006741813	9846,4406
5	10023,4600	0,0039	0	9,68E-02	0,000652724	0,0033	0,003924547	9972,3512
6	9971,4102	-0,0023	0	9,68E-02	0,000379964	-0,0026	-0,002261079	10000,8229
7	9940,0098	-0,0014	0	9,68E-02	-0,000218911	-0,0012	-0,00136977	9957,7624
8	9814,7695	-0,0055	0	9,68E-02	-0,000132617	-0,0054	-0,005506708	9885,4251
9	9856,2197	0,0018	0	9,68E-02	-0,000533144	0,0024	0,001830271	9832,7515
10	10006,8799	0,0066	0	9,68E-02	0,000177202	0,0064	0,006588312	9921,3720

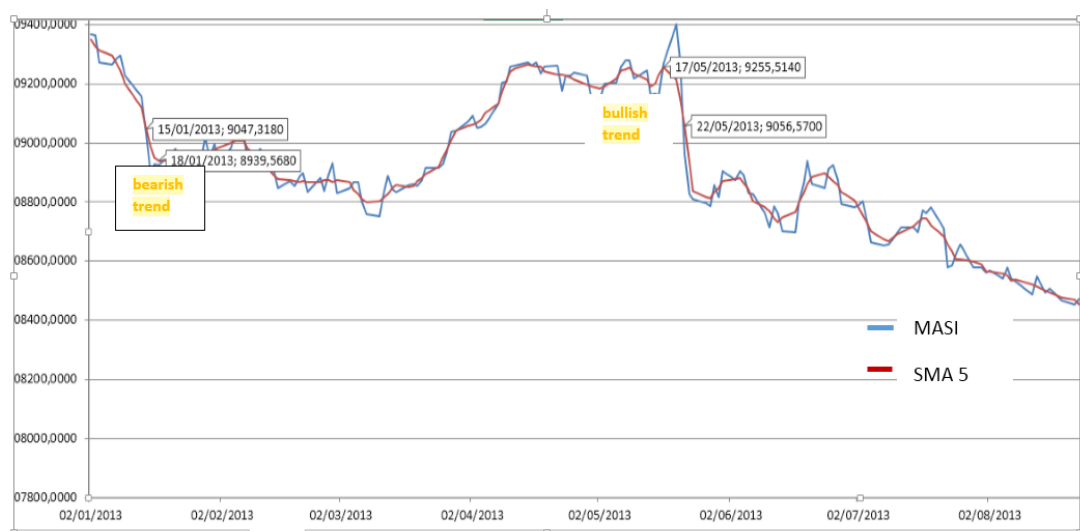
Source: Established by the author

Thus, we notice that the artificial prices generated by the RW(α) process are almost equal to those generated by the AR(1) process, but a little far from the actual MASI values.

C. Identification of Trends and Buy / Sell Signals

1. Technique 1

Among the techniques known to identify trends and their strengths is the curve analysis of stock market indicator with the curve of the 5-order moving average of this indicator.



Source: established by the author using data from the Casablanca Stock Exchange website

Figure 9. Part of the MASI Curve of 2013

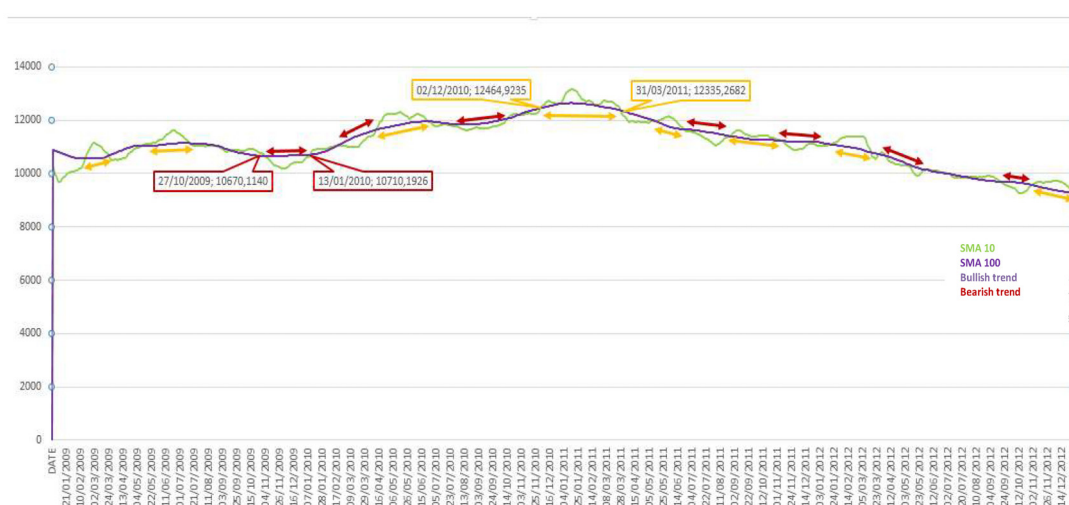
Here are some examples of trends that could be detected through the analysis of these two curves:

- a. Bearish trend from 01/15/2013 to 01/18/2013 (MASI below the moving average 5)
- b. Bullish trend from 05/17/2013 to 05/22/2013 (MASI above moving average 5)

The choice of other periods for the same technique is also deliberate by the financiers, for example analyzing the index curve with the moving average of order 200 or 20.

2. Technique 2

The second technique shown in this figure is the analysis of two moving averages, one short term (10 day period in our case) and another long term (100 day period).



Source: established by the author using data from the Casablanca Stock Exchange website

Figure 10. MASI Moving Average (10 and 100) Curve from 2009 to 2012

Below are some examples of trends and signals detected from this graph:

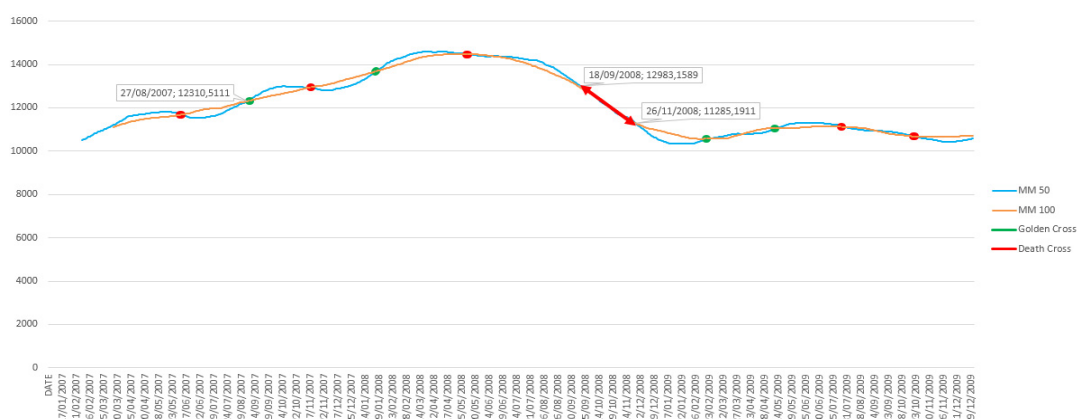
- a. A Bullish trend: from 12/02/2010 to 03/31/2011 (the moving average 10 below the moving average 100).
- b. A Bearish trend: from 27/10/2009 to 13/01/2010 (the moving average 10 above the moving average 100).
- c. Buy signals: on 12/02/2010 and 01/13/2010 (the curve of the moving average of the shorter period cuts the curve of the moving average of the long period from bottom to top).
- d. Sell signals: on 10/27/2009 and 03/31/2011 (the

curve of the moving average of the shortest period crosses from top to bottom the curve of the moving average of the long period).

This technique is also used by financiers with other moving average orders, such as, the 20 moving average with 50.

3. Technique 3

The study of the curves of moving averages of order 50 and 100, is a trading strategy well known for detecting strong buy / sell signals.



Source: established by the author using data from the Casablanca Stock Exchange website

Figure 11. MASI Moving Average (50 and 100) Curve from 2007 to 2009

The third figure shows the “Golden Cross” and “Death Cross” signaled by this famous strategy:

A strong buy signal is detected when the moving average 50 crosses the moving average 100 on the upside. This crossing is called the “Golden Cross”

A strong sell signal is given when the moving average 50 crosses the moving average 100 on the downside. This crossing is called the “Death Cross”

VII. Conclusion

This paper aimed to study the dynamics of the MASI, to checking efficiency of the Moroccan stock market by verifying whether the MASI returns conform to those generated via two random processes that are frequently used by financiers and econometers in the field of stock market.

Another purpose of this paper is to checking stability of this market by using the SMA technique to analyze the fluctuations of this index in order to identify trends and build buy / sell decision.

The motivation that accompanied this research is the testimony of our small economic study, which aimed to know if the variations of MASI accompany the evolution of the added value in each sector of

activity during the same period in empirical study. The evidence of the results of this economic analysis is concluded precisely from the approximate equality of the variables: the percentage frequency of publicly traded company in each sector, the share of market capitalization of each sector and the average value added per sector as a percentage of total value added in that period, at the level of each sector, as well as at the level of the total (see Figure 3).

Our empirical results indicate that both the random walk with a drift and the autoregressive process of order one are less adequate to describe the MASI prices series. The curves in Part III show the feasibility of SMA in smoothing seasonal variations and eliminating background noise from the MASI closing prices curve, this implies that we can read trends quickly and identify signals easily, which can prove that the Moroccan stock market is less efficient and really stable.

The contribution of this study for the Casablanca Stock Exchange is to gain a better understanding of its main index, that is to say, a good knowledge of the evolution, the dynamics and the model of generation of MASI data. This therefore makes it possible to correctly manage the Moroccan stock market risk, to price precisely the derivative products associated with this index, and to make accurate forecasts in order to avoid crises.

Another important implication of this study that

is the need to find better appropriate models to describe the MASI return series.

References

- Adjasi, C. K. (2004). Stock market volatility in African Markets: the Case Study of Ghana Stock Exchange. *First African Finance Journal*, 3(3), 25-35.
- Aggarwal, D. (2019). Do bitcoins follow a random walk model? *ELSEVIER*, 73(1), 15-22. doi:10.1016/j.rie.2019.01.002
- Agence Ecofin. (2018). Classement des Bourses africaines en termes de capital flottant, selon le cabinet RisCura. Retrieved from <https://www.agenceecofin.com/bourses/2109-60161-classement-des-bourses-africaines-en-termes-de-capital-flottant-selon-le-cabinet-riscura>
- Alagidede, P. (2008). *Market Efficiency and Stock Return Behaviour in Africa's Emerging Equity Markets* (Ph.D. Thesis). Loughborough University.
- Bouteiller, X., & Finck, Y. (2007). BOTRAIDERS. Des Traders Et Des Mathématiciens Pour Prévoir La Bourse. Retrieved from <https://www.botraidere.com/services#quand-acheter>
- Centre Régional d'Investissement de Casablanca-Settat (CRI). (2017). <https://www.casainvest.ma/fr>
- Coffie, W. (2017). Conditional Heteroscedasticity and Stock Market Returns: Empirical Evidence from Morocco and BVRM. *Journal of Applied Business and Economics*, 19(5), 43-57.
- Enders, W., & Lee, J. (2005). *Testing for a Unit-root with a Nonlinear Fourier Function* (Mimeo). University of Alabama.
- Falloul, M. E. M., & Mansouri, A. (2014). MASI Index: An Attempt of Modeling Using ARIMA and GARCH Models. *International Journal of Innovation and Applied Studies*, 7(4), 1560-1573, ISSN 2028-9324.
- Fama, E. F. (1965). The Behavior of Stock Market Prices. *Journal of Business*, 38, 34-105.
- Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 25, 383-417.
- Smith, G., Jefferis, K. & Ryoo, H. J. (2002). African Stock Markets: Multiple Variance Ratio Tests of Random Walks. *Applied Financial Economics*, 12(7), 475-484.
- Hassainate, M. S., & Bachisse, M. (2016). Econometric Study of Informational Efficiency of The Moroccan Stock Market: ARIMA Model By Time Series of MASI Index. *Revue d'Etudes en Management et Finance d'Organisation*, 2, 1-18.
- Jefferis, K., & Smith, G. (2005). The Changing Efficiency of African Stock Markets. *South African Journal of Economics*, 73(1), 54-67.
- Joel, E., Alagidede, A. A. P., Mensah, L., & Ohene-Asare, K. (2018). Non-linear Approach to Random Walk Test in Selected African Countries. *International Journal of Managerial Finance*, 14(3), 362-376.
- Jovanovic, F. (2009). Le Modèle De Marche Aléatoire Dans L'économie Financière De 1863 À 1976. *Revue d'Histoire Des Sciences Humaines*, 20, 51-78.
- Kung, J. J., & Carverhill, A. P. (2012). A Bootstrap Analysis of the Nikkei 225. *Journal of Economic Integration*, 27(3), 487-504.
- Lagoarde-Segot, T., & Lucey, B. M. (2008). Efficiency In Emerging Markets-Evidence from the MENA region. *Int. Fin. Markets, Inst. and Money*, 18, 94-105.
- Lo, A. W., & MacKinlay, A. C. (1989). The size and power of the variance ratio test in finite samples: A Monte Carlo investigation. *Journal of Econometrics*, 40, 203-238
- Marius, S. (2019). *Processus Autorégressif A Bruits Gaussiens Stationnaires*. Laboratoire Manceau de Mathématiques, Le Mans Université. France.
- Mendee, E., & Jun, S. G. (2021). Do Short Selling and Margin Trading Affect Price Randomness? *Global Business & Finance Review*, 26(3), 1-13
- Nwosu, E. O., Oji, A., & Anagwu, O. (2013). African Emerging Equity Markets Re-examined: Testing the Weak Form Efficiency Theory. *African Development Review*, 25(4), 485-498.
- Palamalai, S., Kumar, K. K., & Maity, B. (2021). Testing the Random Walk Hypothesis for Leading Cryptocurrencies. *Borsa Istanbul Review*, 21(3), 256-268.
- Regnault, J. (1863). *Calcul des Chances et Philosophie de La Bourse*. Paris: Mallet-Bachelier [et] Castel.
- The Casablanca Stock Exchange database. (2019). <https://www.casablanca-bourse.com/bourseweb/index.aspx>
- The Casablanca Stock Exchange. (2021). Historique. Retrieved from <https://www.casablanca-bourse.com/bourseweb/content.aspx?IdLink=3&Cat=1>
- Yanmi, T. (2019). Classement 2019 des Bourses en Afrique, Marqué Par La Fébrilité Généralisée. Jeune Afrique. Sources: BRVM, SE, SE OF MAURITIUS, THE NIGERIAN SE, BOURSE DE CASABLANCA. Retrieved from <https://www.jeuneafrique.com/mag/847644/economie/classement-2018-des-bourses-en-afrique-marque-par-la-febrilite-generalisee/>
- Web site of data used in Figures 3 and 4:
<https://lematin.ma/bourse-de-casablanca/cours-valeurs.html#secteur1>
https://www.finances.gov.ma/Publication/depf/2019/Tableau_de_bord_sectoriel_janvier%202019.pdf