TESTING OF WEAK FORM EFFICIENT MARKET HYPOTHESIS: EVIDENCE FROM THE CASABLANCA BOURSE (2010-2019)

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Received: 04/10/2020/ **Accepted**: 01/03/2022 / **Published**: 20/02/2023
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ABSTRACT

Investors need to have an idea about stock market before making investment whether the stock markets are efficient or not to take investment decision in stock market. For that reason, measurement of market efficiency of stock market bears significance to investors. Bearing it in mind, In this paper, we employ various tests to investigate the weak form of the efficient market hypothesis for Casablanca bourse over the period from January 2010 until December 2019, This is done by time series stability tests used to test the weak form efficiency and by using the MADX index that represents full stocks in the Casablanca Bourse. During the period of study. The results show that prices in the financial market follow the hypothesis of random walk, so, it is not possible to achieve extraordinary profits through the use of historical prices in order to predict future prices on the Casablanca bourse.

KEYWORDS: Efficiency Hypothesis, WeakForm, Time SerieStability, Casablanca Stock Market.

JEL CLASSIFICATION: G11, G12, G15.

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اختبار فرضية كفاءة أسواق الأوراق المالية عند المستوى الضعيف: دراسة حالة بورصة الدار البيضاء (2010–2019)

ملخص

يتوقف القرار الاستثماري في الأسواق المالية على طبيعة حركة الأسعار فيها، وقدرة المستثمرين على التنبؤ بهذه الحركة مستقبلا من خلال استخدام الأسعار التاريخية، أو ما يطلق عليه مستوى كفاءة السوق المالية.

سنحاول في هذه الورقة التحقق من فرضية السوق الكفؤة لسوق الأسهم بالدار البيضاء، خلال الفترة الممتدة من جانفي 2010 إلى ديسمبر 2019، عن طريق اختبارات ثبات السلاسل الزمنية المستخدمة لاختبار الشكل الضعيف الكفاءة، وباستخدام مؤشر MADX الذي يمثل الأسهم الكاملة في بورصة الدار البيضاء خلال فترة الدراسة.

خلصنا إلى أن الأسعار في السوق المالية تتبع فرضية السير العشوائي، أي أنه لا يمكن تحقيق أرباح غير عادية من خلال استخدام الأسعار التاريخية للتنبؤ بالأسعار المستقبلية في بورصة الدار البيضاء، وبالتالي سوق الأسهم للدار البيضاء تتمتع بالكفاءة عند المستوى الضعيف.

كلمات المفتاحية: فرضية الكفاءة، المستوى الضعيف، استقرار السلاسل الزمنية، سوق الأسهم للدار البيضاء.

TESTER LA FORME FAIBLE DE L'HYPOTHESE D'EFFICIENCE DU MARCHE FINANCIERS : PREUVE DE LA BOURSE DE CASABLANCA (2010-2019)

RÉSUMÉ

Les investisseurs doivent avoir une idée du marché boursier avant d'investir, que les marchés boursiers soient efficients ou non pour prendre une décision d'investissement en bourse. Pour cette raison, la mesure de l'efficience du marché boursier est importante pour les investisseurs. En gardant cela à l'esprit, dans cet article, nous utilisons divers tests pour étudier la forme faible de l'hypothèse de marché efficient pour les marchés boursiers de Casablanca sur la période allant de janvier 2010 à décembre 2019 Ceci est fait par des tests de stabilité de séries chronologiques utilisés pour tester la forme faible de l'efficience, et en utilisant l'indice MADX qui représente les valeurs pleines de la bourse de Casablanca. Pendant la période d'étude.
Nous avons conclu que les prix sur le marché financier suivent l'hypothèse de la marche aléatoire, c'est-à-dire qu'il n'est pas possible de réaliser des profits extraordinaires grâce à l'utilisation de prix historiques afin de prédire les prix futurs à la Bourse de Casablanca.

KEY WORDS: Hypothèse d'Efficience, Forme Faible, Stabilité des Séries Chronologiques, Bourse de Casablanca.

JEL CLASSIFICATION: G11, G12, G15.

INTRODUCTION

Despite the various and rapid developments witnessed by many financial markets, the focus remains on the efficiency of these markets in performing their mission and achieving the efficient allocation of financial resources available for investment.

A market is said to be efficient with respect to an information set if the price 'fully reflects' that information, if the price is unaffected by revealing the information set to all market participants.

Furthermore, the concept of achieving pure market efficiency has been a subject of academic and professional debate for years due to several reasons. Firstly, it is expected that risk-weighted returns would be greater in inefficient stock markets. Thus, an examination of stock market efficiency is vital for individual and institutional investors in both the private and public sectors.

With the concept of the efficiency of financial markets, it is expected that the prices of the security will respond to changes in the information received to the market, so that the market value of the securities is a fair value that reflects their real value, and this response occurs quickly so that no group of investors can achieve gains other than Normal

And there were numerous proficiency tests at all levels, and according to the different nature of the markets, whether developed or emerging, the efficient market hypothesis (EMH) asserts that financial markets are efficient.

Given that the Casablanca market is one of the emerging markets, which is no less important than its counterparts, in this paper, we will try to test its efficiency after we give a chronological review of the notable literature relating to the EMH. by answering the following problem: Is it possible to predict future prices based on historical prices on the Casablanca stock market?

1- HISTORICAL FRAMWORK

Efficiency theory began as an intellectual trend formed since the emergence of the work of "Louis Bachelier" in 1900 In his doctoral thesis, The Theory of Speculation" in which he tried to demonstrate a random movement of prices in the financial market, and Bachelier's thesis is now considered pioneering in the field of financial mathematics. (Bachelier, 1900)

In 1953, Kendall analysed 22 price-series at weekly intervals and found to his surprise that they were essentially random. Also, he was

the first to note the time dependence of the empirical variance (nonstationary) (Kendall & A. Bradford, 1953).

In 1961, Alexander realised that spurious autocorrelation could be introduced by averaging; or if the probability of a rise is not 0.5,he concluded that the random walk model best fits the data, but found leptokurtosis in the distribution of returns (Alexander, 1961)

In 1964, Steiger tested for non-randomness and concluded that stock prices do not follow a random walk (Steiger, 1964).And in the same year, Sharpe published his Nobel prize-winning work on the CAPM (Sharpe, 1964)

Fama who is considered the spiritual father of the theory- defined an "efficient" market for the first time in 1965 (Fama E. F., 1965), in his landmark empirical analysis of stock market prices , he explained how the theory of random walks in stock market prices presents important challenges to the proponents of both technical analysis and fundamental analysis.

Published in 1970, the definitive paper on the EMH is Eugene F. Fama's first of three review papers, and he defines an efficient market as follows: A market in which prices always fully reflect available information is called « efficient » ; He was also the first to consider the joint hypothesis problem. (Fama E. F., 1970)

In 1978 and for his part Jensen famously wrote 'I believe there is no other proposition in economics which has more solid empirical evidence supporting it than the EMH. (Jensen, 1978)

Robert J. Shiller reviewed the problems of risk measurement (estimating beta) when shares are subject to infrequent trading. He showed that the volatility of long-term interest rates is greater than predicted by expectations models. (Shiller R. , 1979)

In 1985, Werner F. M. De Bondt and Richard Thaler discovered that stock prices overreact, evidencing substantial weak form market inefficiencies. This paper marked the start of behavioural finance. (De Bondt & Thaler, 1985)

Roll observed in 1994 that in practice it is hard to profit from even the strongest market inefficiencies. He provided new evidence concerning market microstructure and stock return predictions. He found that portfolios of stocks chosen by experts do not consistently beat the market. (Roll, 1994)

In 2000, Shleifer published Inefficient Markets: An Introduction to Behavioral Finance, which questions the assumptions of investor rationality and perfect arbitrage. Published a selective survey of finance.(Shleifer, 2000)Shiller published in same year the first edition of Irrational Exuberance, which challenges the EMH, demonstrating that markets cannot be explained historically by the movement of company earnings or dividends. (Shiller R. , 2000),

In 2000, Eugene Fama became the first elected fellow of the American Finance Association. In an excellent historical review paper.

and in 2013 Fama and Shiller, were awarded the Nobel Prize for Economics for their contributions to the development of the EMH and the empirical analysis of asset prices.

2- REVIEW OF THE EMPIRICAL EVIDENCE

2.1- What Is Market Efficiency?

The efficient-market hypothesis (EMH) is a hypothesis in financial economics that states that asset prices reflect all available information. A direct implication is that it is impossible to "beat the market" consistently on a risk-adjusted basis since market prices should onlyreact to new information. Since risk adjustment is central to the EMH, and yet the EMH does not specify a model of risk, the EMH is untestable. (Fama E. F., 1970).

The basic efficient market hypothesis posits that the market cannot be beaten because it incorporates all important determining information into current share prices. Therefore, stocks trade at the fairest value, meaning that they can't be purchased undervalued or sold overvalued.

2.2- Principles of EMH

If we want to shortly summarise the points mentioned above, we can say the following as the basic characteristics of an efficient market, under the efficient market hypothesis:(مفتاح و معارفي، 2009-2010)

Random walks determine changes in stock prices;

- The Efficient Market Hypothesis assumes all stocks trade at their fair value;

- All new information immediately is reflected within the stock prices. Also, these information cannot be used in order to earn excess profits. The theory assumes it would be impossible to outperform the market and that all investors interpret available information the same way;
- Not much use can be obtained through a technical analysis;
- Outperforming the market is near impossible, even for the fund managers;
- Economic fundamentals determine and fix the levels of stock prices.

2.3- Theorecal foundations of the EMH

At the core of the EMH lies the following three basic premises: (Andrew & other, 2010)

2.3.1. Investor rationality: It is assumed that investors are rational, in the sense that they correctly update their beliefs when new information is available;

2.3.2. Arbitrage: individual investment decisions satisfy the arbitrage condition, and trade decisions are made, guided by the calculus of the subjective expected utility theory a la Savage;

2.3.3. Collective rationality: The random errors of investors cancel out in the market.

This requires individual errors (departures from individual rationality) to be cross section ally independent or at least only weakly correlated.

2.4- Forms of market efficiency

There are three degrees of market efficiency: (Ceyda & Other)

2.4.1. Weak-form: Efficient Market is one in which past prices and volume figures are of no use in predicting future stock price changes and beating the market because current prices reflect all historical information;

- If so, then technical analysis is of little use;
- If so, then one should simply use a buy-and-hold strategy.

2.4.2. Semistrong-form: Efficient Market is one in which publicly available information is of no use in beating the market because current security prices reflect all public information.

- If so, then fundamental analysis is of little use, but "inside" information may be illegally valuable;
- Any price anomalies are quickly found out and the stock market adjusts accordingly.

2.4.3. Strong-form: Efficient Market is one in which information of any kind, public or private, is of no use in beating the market because prices reflect all public and private information.

- If so, then "inside information" is of little use;
- This assumes perfect markets in which all information is cost-free and available to everyone at the same time.

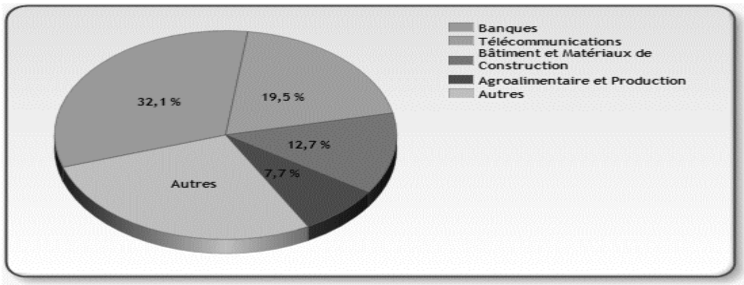
3- METHODS AND MATERIALS

3.1- The study sample

Through this study, we aim to test the efficiency of the stock market in Casablanca,

The Casablanca Stock Exchange is a stock exchange in Casablanca, Morocco. The Casablanca Stock Exchange (CSE).Which achieves one of the best performances in the region of the Middle East and North Africa (MENA), is Africa's third largest Bourse after Johannesburg Stock Exchange (South Africa) and Nigerian Stock Exchange in Lagos. It was established in 1929 and currently has 19 members and 81 listed securities with a total market capitalization of $71.1 billion in 2018**.**
The share of the banking sector contribution32%, followed by the sector of Telecommunications 19.5%, building and construction material 12.7%, food industry 7.7%, and others 28%.(figure 1).

Figure 1. Sectoriel capitalisation



Source: http://www.casablanca- bourse.com/bourseweb/en/index.aspx# Consulted the 09, 04, 2020.

Historical databases of daily prices were downloaded from the Casablanca Stock Exchange (Bourse de Casablanca),(Bourse) These databases were for almost 10 years of daily prices and were essential elements for carrying out this research, by testing the hypothesis of the random flow of prices obtained through the daily observations of the index for the period 01/01/2010 to 12/31/2019 and thus we get 2806 observations**.**

In the process of analysing the data, firstly, the daily stock's returns of the 11 sample stocks, as well as the daily returns of the MADX index, have been calculated. These daily returns are, in fact, essential ingredients for the calculation of standard deviations, correlation matrices, stocks' betas, skewness and kurtosis of all the sample stocks and their relationship vis-à-vis the MADX index.

3.2- Descriptive Statistical Study of The Series

By drawing original observations, we see the fluctuation is evident in the Figure 2 ,Where we see an increase in the index MADX in the first period, and it decreases in the second period, and it rises again in a third period. This suggests instability of the time series

Figure 2. Series Prices MADX

Source: Prepared by researchers depending on the program eviews 7.

The time series scored a mean of 8778.718 points, and median equal to 8939.555 points, where we recorded the highest value equal to10965.49 point sand the lowest value is equal to 6782.180 points, the series values are dispersed from their mean, with a standard deviation of 1030.342 points

3.3- Test the Stability of the Time Series for Daily Returns

In order to test the efficiency of stock markets at the weak level, we test the stability and properties of the time series, despite the many stability tests, we relied in this study on two basic tests:

- Graphical representation of the autocorrelation functions
- Unit Root Test by Dickey-Fuller test and Phillips-Perron test

3.3.1. Auto-correlation test . This test is considered one of the tests for the stability of the time series of returns, which is a teacher test used to determine the relationship between financial returns in the current period and their value in the previous period, and this test aims to determine the extent of the independence of the returns of the portfolio from each other and from zero**.**

The mathematical formula for auto-correlation can be expressed in the following relationship:

$$\hat{\rho}=\frac{\sum_{t=1}^{t}(y_t-\bar{\bar{y}})(y_{t+k}-\bar{\bar{y}})}{\sum_{t=1}^{t}(y_t-\bar{\bar{y}})^2}$$

If the function $\hat{\rho}$ is well-defined, its value must lie in the range [1-,1+], with + 1 indicating perfect correlation, and −1 indicating perfect anti-correlation. In the stable state, the correlation value is equal to zero.

- Significant Auto-Correlation Coefficients Test.

If the returns are Auto -related, a correlation coefficient that differs from zero, then this means that there is a relationship between the returns, which means that the daily returns depend on historical returns

- Ljung-Box Test.

We use this test to study the significance of the coefficients of the auto-correlation function; this is according to the following two hypotheses:

$$H_0: \; P_1 = P_2 = \cdots = P_n$$

$$H_1: \text{at least } P_i \neq 0$$

3.3.2. Unit Root Test. A stable time series is one that is devoid of the unit root.

This is according to the following two hypotheses:

H_0: Series has a unit root (non-stationary),

H_1: Series has not unit root (stationary).

Perhaps the most important method is the Dickey Fuller Augmented test and the Phillips and Perron test.

a- ADF test: The Augmented Dickey Fuller Test (ADF) is unit root test for stationary. Unit roots can cause unpredictable results in your time series analysis, The Augmented Dickey-Fuller test can be used with serial correlation.

The ADF test can handle more complex models than the Dickey-Fuller test .The three basic regression models are:

– The first model: No constant, no trend: $\Delta Y_t = \lambda Y_{t-1} + \varepsilon$
– The second model: Constant, no trend: $\Delta Y_t = \alpha + \lambda Y_{t-1} + \varepsilon$
– The Third model: Constant and trend: $\Delta Y_t = \alpha + \lambda Y_{t-1} + \beta t + \varepsilon$.

Testing the hypothesis:

$$H_0: \lambda = 0$$
$$H_0: \lambda < 0$$

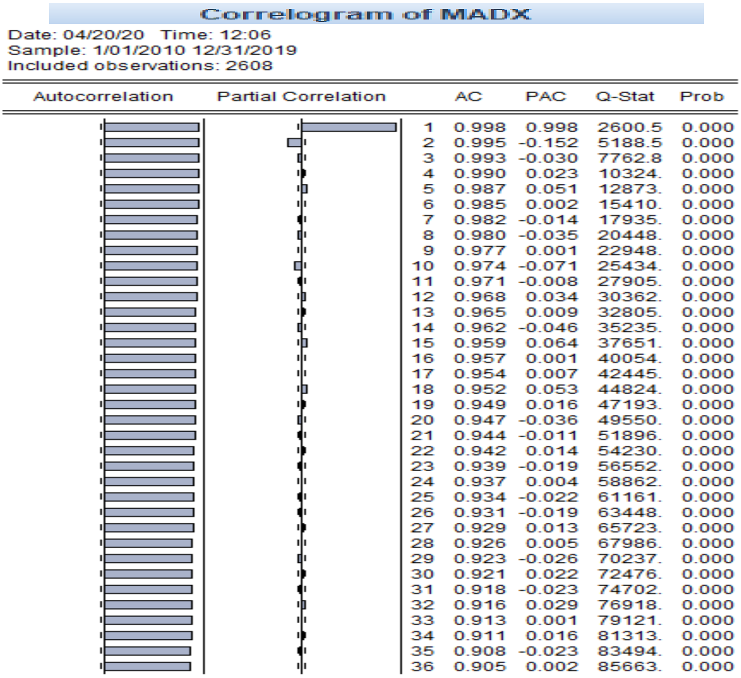
b- PP test: The Phillips–Perron test is a unit root test that is, it is used in time series analysis to test the null hypothesis that a time series is integrated of order, whilst the augmented Dickey–Fuller test addresses this issue by introducing lags of as regressors in the test equation, the Phillips–Perron test makes a non-parametric correction to the t-test statistic. The test is robust with respect to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test equation

4- RESULTS AND DISCUSSION

4.1- Auto-correlation

- Through the representation of the simple and partial Auto - correlation function, it is clear that the Seri is unstable as all the auto-correlation coefficients are outside the field of confidence expressed in the two parallel lines
- As the first value of the correlation 0.998 is close to the correct one and the following values are less than it but it is still high then, this means that the chain is directed to its normal level after any slight disruption .So any move up or down will continue to a long period before returning to the normal level.
- For this, we compare the calculated LB with the tabulated value extracted from the Kay squared table with a freedom degree of 36 and a 5% level of significance, where the calculated test statistic LB corresponds to the last value in the Q-stat column in the figure 3, And that equals to 85663, It is greater than the scheduled value,$X^2_{(0.05.36)}$=50.998.

Figure 3. MADX Auto-correlation



Correlogram of MADX

Date: 04/20/20 Time: 12:06
Sample: 1/01/2010 12/31/2019
Included observations: 2608

Lag	AC	PAC	Q-Stat	Prob
1	0.998	0.998	2600.5	0.000
2	0.995	-0.152	5188.5	0.000
3	0.993	-0.030	7762.8	0.000
4	0.990	0.023	10324.	0.000
5	0.987	0.051	12873.	0.000
6	0.985	0.002	15410.	0.000
7	0.982	-0.014	17935.	0.000
8	0.980	-0.035	20448.	0.000
9	0.977	0.001	22948.	0.000
10	0.974	-0.071	25434.	0.000
11	0.971	-0.008	27905.	0.000
12	0.968	0.034	30362.	0.000
13	0.965	0.009	32805.	0.000
14	0.962	-0.046	35235.	0.000
15	0.959	0.064	37651.	0.000
16	0.957	0.001	40054.	0.000
17	0.954	0.007	42445.	0.000
18	0.952	0.053	44824.	0.000
19	0.949	0.016	47193.	0.000
20	0.947	-0.036	49550.	0.000
21	0.944	-0.011	51896.	0.000
22	0.942	0.014	54230.	0.000
23	0.939	-0.019	56552.	0.000
24	0.937	0.004	58862.	0.000
25	0.934	-0.022	61161.	0.000
26	0.931	-0.019	63448.	0.000
27	0.929	0.013	65723.	0.000
28	0.926	0.005	67986.	0.000
29	0.923	-0.026	70237.	0.000
30	0.921	0.022	72476.	0.000
31	0.918	-0.023	74702.	0.000
32	0.916	0.029	76918.	0.000
33	0.913	0.001	79121.	0.000
34	0.911	0.016	81313.	0.000
35	0.908	-0.023	83494.	0.000
36	0.905	0.002	85663.	0.000

Source/ Prepared by researchers depending on the program eviews 7.

– So, we reject the hypothesis that all self-correlation coefficients are equal to zero, thus the chain is unstable, and we can make it stable by difference figure 4

Figure 4: DMADX Auto-Correlation

Correlogram of D(MADX)

Date: 04/20/20 Time: 12:09
Sample: 1/01/2010 12/31/2019
Included observations: 2607

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.165	0.165	70.916	0.000
		2	0.055	0.029	78.872	0.000
		3	-0.009	-0.023	79.084	0.000
		4	-0.053	-0.050	86.292	0.000
		5	-0.002	0.016	86.304	0.000
		6	-0.010	-0.008	86.547	0.000
		7	0.014	0.015	87.054	0.000
		8	-0.010	-0.017	87.338	0.000
		9	0.056	0.062	95.686	0.000
		10	0.051	0.034	102.39	0.000
		11	-0.007	-0.026	102.54	0.000
		12	0.046	0.049	108.17	0.000
		13	0.034	0.029	111.22	0.000
		14	-0.004	-0.016	111.26	0.000
		15	-0.009	-0.010	111.49	0.000
		16	-0.053	-0.046	118.82	0.000
		17	-0.012	0.007	119.23	0.000
		18	-0.000	0.003	119.23	0.000
		19	0.031	0.023	121.77	0.000
		20	0.024	0.012	123.28	0.000
		21	0.008	-0.002	123.43	0.000
		22	0.029	0.020	125.67	0.000
		23	-0.002	-0.006	125.69	0.000
		24	0.012	0.012	126.06	0.000
		25	0.025	0.027	127.74	0.000
		26	-0.013	-0.017	128.18	0.000
		27	-0.010	-0.009	128.42	0.000
		28	0.012	0.021	128.79	0.000
		29	-0.011	-0.015	129.10	0.000
		30	0.013	0.014	129.55	0.000
		31	-0.015	-0.025	130.16	0.000
		32	-0.003	-0.003	130.17	0.000
		33	-0.032	-0.031	132.86	0.000
		34	0.005	0.011	132.93	0.000
		35	0.010	0.009	133.18	0.000
		36	0.015	0.018	133.76	0.000

Source/ Prepared by researchers depending on the program eviews 7.

4.2- Unit Root Test

4.2.1. ADF test

When estimating the Dicky Fuller models, we get the following results:

- When estimating the third model that was not significant at 10% .So that :prob = 0.**894**>0.1, (Appendix :1), Which makes us go down to the second model;
- When estimating the second model, this model was significant at 5% , because prob = 0.0306 <0.05, and whereas, the absolute value

of the ADF statistic 1.733,it is less than the critical values(3.432, 2.862, 2.567) at the level of significance(1%,5%,10%) levels respectively(Appendix :2);

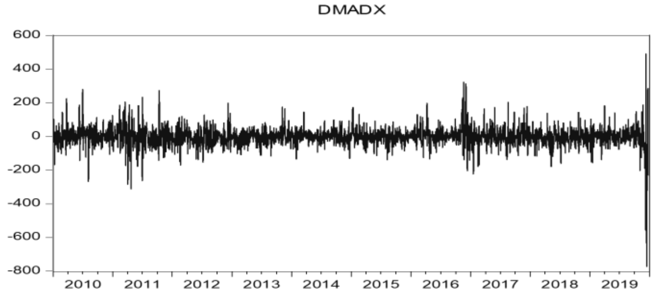
- Thus, we accept the null hypothesis and the existence of a unit root in the series , which makes it unstable :
- At the first difference and estimate models, We found : prob = 0.6811> 0.1 (Appendix :3), and prob=0.4097 (Appendix :4), For the third and second models, respectively, so the two models were not significant;
- The first model for the first difference was significant ,when prob = 0.0000 <0.01, and where as, the absolute value of the ADF statistic 43.218 it is more than the critical values (2.565, 1.941, 1.616) at the level of significance(1%,5%,10%) levels respectively (Appendix:5);
- And from it we accept the alternative hypothesis that the series is free of unit root and therefore we judge that the series is static at the first difference, which makes it stable.

4.2.2. PP Test

The results of PP test are consistent with the results of the Dicky Fuller test, So that:

- When estimating the second model, this model was significant at 5% , because prob = 0.0305 <0.05, and where as, the absolute value of the ADF statistic 1.566,it is less than the critical values(3.432, 2.862, 2.567) at the level of significance(1%,5%,10%) levels respectively (Appendix :6).
- We accept the null hypothesis and the existence of a unit root in the series, which makes it unstable.
- The first model for the first difference was significant ,when prob = 0.0000 <0.01, and where as, the absolute value of the PP statistic 43.193 it is more than the critical values (2.565, 1.941, 1.616) at the level of significance(1%,5%,10%) levels respectively (Appendix :7);
- We accept the alternative hypothesis that the series is free of unit root and therefore, we judge that the series is static at the first difference, which makes it stable. Figure 5.

Figure 5. Stability of Serie Prices DMADX



Source: Prepared by researchers depending on the program eviews 7.

CONCLUSION

Just under half of the papers reviewed support market efficiency, and in this paper, we tried to test the efficiency of an emerging market and we examined the random walk hypothesis of the MADX index price for daily observations of the past 15 years.

We have analysed the stock prices given on the indices MADX in order to see if they are weak form efficient and if there are opportunities that can be exploited. Using the Auto-correlation test , the ADF test, PP test data from January 2010 to December 2019 were analysed the study concluded :

– Time Series Stability Test Prove that the price is stable for the first difference.
– As a result of all the previous tests, we conclude that the Casablanca stock market is considered an efficient market at the weak level ,
– This indicates that the investor cannot achieve abnormal returns. So the market price is unpredictable in the short term.

The proposals made through the field study:

– These results provided an interesting ground for comparison to information efficiency literature, especially focusing on the post crisis period.

– However, knowing that the amount of resources and opportunities are still much higher in emerging economies, it is important to gather as much information about these markets.

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Appendix

Appendix 1. Third model – ADF

Null Hypothesis: MADX has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.688453	0.7564
Test critical values:	1% level	-3.961565	
	5% level	-3.411532	
	10% level	-3.127629	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MADX)
Method: Least Squares
Date: 04/20/20 Time: 12:46
Sample (adjusted): 1/05/2010 12/31/2019
Included observations: 2606 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MADX(-1)	-0.002016	0.001194	-1.688453	0.0914
C	17.69126	10.42552	1.696918	0.0898
@TREND(1/01/2010	-0.000218	0.001635	-0.133131	0.8941
R-squared	0.028303	Meandependentvar		-0.351393
Adjusted R-squared	0.027182	S.D. dependent var		62.80945
S.E. of regression	61.94991	Akaike info criterion		11.09206
Sumsquaredresid	9985933.	Schwarz criterion		11.10107
Log likelihood	-14448.96	Hannan-Quinn criter.		11.09532
F-statistic	25.26288	Durbin-Watson stat		2.008016
Prob(F-statistic)	0.000000			

Source: Prepared by researchers depending on the program eviews 7

Appendix 2. Second model test ADF

Null Hypothesis: MADX has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.733002	0.4144
Test critical values:	1% level	-3.432666	
	5% level	-2.862449	
	10% level	-2.567299	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MADX)
Method: Least Squares
Date: 04/20/20 Time: 12:49

Sample (adjusted): 1/05/2010 12/31/2019				
Included observations: 2606 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
MADX(-1)	-0.002042	0.001178	-1.733002	0.0832
C	17.63269	10.41427	1.693128	0.0306
R-squared	0.028296	Mean dependent var		-0.351393
Adjusted R-squared	0.027549	S.D. dependent var		62.80945
S.E. of regression	61.93822	Akaike info criterion		11.09130
Sumsquaredresid	9986001.	Schwarz criterion		11.09805
Log likelihood	-14448.97	Hannan-Quinn criter.		11.09375
F-statistic	37.89976	Durbin-Watson stat		2.008027
Prob(F-statistic)	0.000000			

Source. Prepared by researchers depending on the program eviews 7

Appendix 3. Third model 1stdifference- ADF

Null Hypothesis: D(MADX) has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 0 (Automatic - based on SIC, maxlag=3)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-43.20580	0.0000
Test critical values:	1% level	-3.961565	
	5% level	-3.411532	
	10% level	-3.127629	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MADX,2)
Method: Least Squares
Date: 04/20/20 Time: 12:51
Sample (adjusted): 1/05/2010 12/31/2019
Included observations: 2606 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MADX(-1))	-0.835229	0.019331	-43.20580	0.0000
C	0.572765	2.430064	0.235700	0.8137
@TREND(1/01/2010	-0.000663	0.001614	-0.410965	0.6811
R-squared	0.417640	Meandependentvar		0.006746
Adjusted R-squared	0.417192	S.D. dependent var		81.17689
S.E. of regression	61.97193	Akaike info criterion		11.09239
Sumsquaredresid	9996875.	Schwarz criterion		11.09914
Log likelihood	-14450.39	Hannan-Quinn criter.		11.09484
F-statistic	933.3710	Durbin-Watson stat		2.007518
Prob(F-statistic)	0.000000			

Source: Prepared by researchers depending on the program eviews 7

Appendix 4. Second model 1^{st}difference - ADF

Null Hypothesis: D(MADX) has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=3)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-43.21075	0.0000
Test critical values:	1% level		-3.432666	
	5% level		-2.862449	
	10% level		-2.567299	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(MADX,2)				
Method: Least Squares				
Date: 04/20/20 Time: 12:51				
Sample (adjusted): 1/05/2010 12/31/2019				
Included observations: 2606 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MADX(-1))	-0.835159	0.019328	-43.21075	0.0000
C	-0.292357	1.213796	-0.240862	0.4097
R-squared	0.417602	Mean dependent var		0.006746
Adjusted R-squared	0.417378	S.D. dependent var		81.17689
S.E. of regression	61.96204	Akaike info criterion		11.09169
Sumsquaredresid	9997523.	Schwarz criterion		11.09619
Log likelihood	-14450.47	Hannan-Quinn criter.		11.09332
F-statistic	1867.169	Durbin-Watson stat		2.007533
Prob(F-statistic)	0.000000			

Source. Prepared by researchers depending on the program eviews 7

Appendix 5. First model 1^{st}difference - ADF

Null Hypothesis: D(MADX) has a unit root			
Exogenous: None			
Lag Length: 0 (Automatic - based on SIC, maxlag=3)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-43.21790	0.0001
Test critical values:	1% level	-2.565850	
	5% level	-1.940945	
	10% level	-1.616618	
*MacKinnon (1996) one-sided p-values.			
Augmented Dickey-Fuller Test Equation			
Dependent Variable: D(MADX,2)			
Method: Least Squares			
Date: 04/20/20 Time: 12:52			
Sample (adjusted): 1/05/2010 12/31/2019			
Included observations: 2606 after adjustments			

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MADX(-1))	-0.835133	0.019324	-43.21790	0.0000
R-squared	0.417589	Meandependentvar		0.006746
Adjusted R-squared	0.417589	S.D. dependent var		81.17689
S.E. of regression	61.95084	Akaike info criterion		11.09094
Sumsquaredresid	9997746.	Schwarz criterion		11.09319
Log likelihood	-14450.50	Hannan-Quinn criter.		11.09176

Source: Prepared by researchers depending on the program eviews 7

Appendix 6. Second model - PP

Null Hypothesis: MADX has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.566046	0.4999
Test critical values:	1% level	-3.432665	
	5% level	-2.862449	
	10% level	-2.567299	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	3939.364
HAC corrected variance (Bartlett kernel)	4591.736

Phillips-Perron Test Equation
Dependent Variable: D(MADX)
Method: Least Squares
Date: 04/20/20 Time: 13:17
Sample (adjusted): 1/04/2010 12/31/2019
Included observations: 2607 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MADX(-1)	-0.001711	0.001194	-1.433176	0.1519
C	14.65412	10.55139	1.388833	0.0305
R-squared	0.000788	Meandependentvar		-0.364818
Adjusted R-squared	0.000404	S.D. dependent var		62.80114
S.E. of regression	62.78844	Akaike info criterion		11.11819
Sumsquaredresid	10269921	Schwarz criterion		11.12269
Log likelihood	-14490.56	Hannan-Quinn criter.		11.11982
F-statistic	2.053992	Durbin-Watson stat		1.668640

Source: Prepared by researchers depending on the program eviews 7

Appendix 7: First model1stdifference- PP

Null Hypothesis: D(MADX) has a unit root
Exogenous: None
Bandwidth: 11 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-43.19314	0.0001
Test critical values:	1% level	-2.565850	
	5% level	-1.940945	
	10% level	-1.616618	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	3836.434
HAC corrected variance (Bartlett kernel)	3809.602

Phillips-Perron Test Equation
Dependent Variable: D(MADX,2)
Method: Least Squares
Date: 04/20/20 Time: 13:20
Sample (adjusted): 1/05/2010 12/31/2019
Included observations: 2606 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MADX(-1))	-0.835133	0.019324	-43.21790	0.0000
R-squared	0.417589	Meandependentvar		0.006746
Adjusted R-squared	0.417589	S.D. dependent var		81.17689
S.E. of regression	61.95084	Akaike info criterion		11.09094
Sumsquaredresid	9997746.	Schwarz criterion		11.09319
Log likelihood	-14450.50	Hannan-Quinn criter.		11.09176
Durbin-Watson stat	2.007543			

Source: Prepared by researchers depending on the program eviews 7