Quantitative Finance and Economics

QFE, 9(3): 631–657.
DOI: 10.3934/QFE.2025022
Received: 07 March 2025
Revised: 16 May 2025
Accepted: 02 July 2025
Published: 25 August 2025

https://www.aimspress.com/journal/QFE

*Research article*

# The weak-form efficient markets hypothesis: Macroeconomic evidence from MEDA capital markets

**Francesco Scalamonti***

Department of Economics, University of Perugia, Umbria, Italy

* **Correspondence:** Email: scala_f@libero.it.

**Abstract:** In this study, we examined efficient market hypothesis (EMH) in the weak form over the period 2011–2020 for five South-Eastern Mediterranean countries (MEDA), with complete time-series: Egypt, Israel, Jordan, Morocco, and Turkey. Therefore, we contributed to the limited literature on MEDA transitional economies and provided preliminary and exploratory evidence based on macroeconomic data. Different classical statistical approaches have been used to analyze variations in time-series of the average annual turnover ratio, chosen as an indirect proxy for market returns and used to compute the market spread ($S_m$), including unit root and variance ratio tests, as well as the Hurst exponent and AR(1) models. Our outcomes revealed that tests and models reject the weak-form EMH for the MEDA capital markets in question. This result may be due to inefficiencies and predictability of MEDA capital markets, such as institutional, regulatory, and information lacks, amplified by exogenous shocks, such as the "Arab Springs" and the global pandemic crisis, occurring in the decade considered.

**Keywords:** market efficiency; EMH; random-walk; capital market; MEDA countries

**JEL Codes:** D53, G11, G14, G15

## 1. Introduction

Globalization has led to an increasingly integrated world economy, including financial and capital markets. This means that domestic and foreign capital flows have been surging ever since, especially in emerging and transitional economies, with North African and Near Middle Eastern (MEDA)

countries[1] as potential frontier markets in the Arab world, in particular for European investors. Additionally, the global pandemic has triggered a rapid transformation of the financial systems (WEF, 2020; Alfaro et al., 2020; Baker et al., 2020; Dias et al., 2020; Ding et al., 2021; Ramelli and Wagner, 2020). Small and large firms needed almost instant liquidity, individuals embraced digital and contactless offerings at unprecedented rates, and countries' governance were looking to disperse enormous aid packages (Guerrieri et al., 2022).

In the MEDA countries, most companies are participated by the state. The financial structures are mainly focused on banking intermediation, and the informal economy is prevalent. However, there have been examples of capital market reforms, especially in Egypt and Turkey, where economic policies have been directed toward an opening to international capital and privatization. Except for Algeria, Libya, and Syria, the other countries have stock exchanges with a longer tradition[2] (Table 1).

The composition and size of most of the MEDA capital markets are affected by their establishment and by the prevalent weight of banking institutions in capital intermediation. Therefore, the major market performance indicators may be affected by this.

The capital market development can be measured in various ways (Table 2). For instance, the number of listed companies remains overall low, except for Turkey. Therefore, it is not surprising that the most significant values are those of Turkey, Israel, and Egypt. Additionally, the Israeli capital market may be structurally closer to those of European and Western countries in general.

Another common feature of all the MEDA capital markets is the electronic market. The stock exchange management is mostly carried out by private agents, except for the Istanbul stock exchange managed by a state-owned company. The markets are supervised by a regulatory authority where it exists, except for Turkey, where supervision is carried out by the Central Bank and the Treasury. Particularly, Turkey has a capital market with a significant number of listed companies and a substantially higher average capitalization, while the stock exchanges of Lebanon and Morocco have few listed companies with high capitalization mainly belonging to the banking, telecommunications, and energy sectors.

[1] The major countries for size and economic importance sorted by per–capita GDP in US$ thousands (WDIs–WB, 2020) are: Israel (44.8), Libya (10.0), Turkey (8.6), Lebanon (5.6), Jordan (4.0), Algeria (3.8), Tunisia (3.5), Morocco (3.3), Egypt (3.6), and Syria (0.5). In other words, they are the major South–Eastern Mediterranean countries identified in the "Barcelona Declaration" in 1995.

[2] The Algerian stock exchange was founded in 1997. The idea of creating a stock exchange in Algeria was part of the economic reforms of the second half of the Nineties, and it was established by dedicate laws. The Libyan stock exchange was established in 2007, introducing a series of financial rules and agreements with other Arab stock exchanges and with the London stock exchange to facilitate its operations. Following the "Arab Springs" upheaval, the stock exchange closed for one year. The Syrian stock exchange was founded in 2009 and has been a member of the Euro-Asian Stock Exchanges Federation since the early 2000 thousands. Following the "Arab Spring" riots, the stock market index collapsed rapidly. These stock markets remain among the smallest stock exchanges in the world, where the absence of specific laws and code of trade suitable for the market economy makes the number of listed companies and their capitalization index extremely limited.

**Table 1.** The general information about MEDA capital markets.

| Country | Stock Exchange | Date of Establishment | Ownerships |
|---|---|---|---|
| Algeria | Bourse d'Algérie | 1997 | Public company |
| Egypt | Egyptian Exchange | 1883 | Public institution |
| Israel | Tel–Aviv Stock Exchange | 1953 | Mutualized |
| Jordan | Amman Stock Exchange | 1999 | Public institution |
| Lebanon | Beirut Stock Exchange | 1920 | Public institution |
| Libya | Libyan Stock Market | 2007 | Public institution |
| Morocco | Bourse de Casablanca | 1929 | Mutualized |
| Syria | Damascus Securities Exchange | 2009 | Public institution |
| Tunisia | Bourse de Tunis | 1969 | Mutualized |
| Turkey | Borsa Istanbul | 1866 | Public institution |

**Table 2.** Some performance indicators of MEDA capital markets (WDIs–WB).

| Indicators | Years | Egypt | Israel | Jordan | Lebanon | Morocco | Tunisia | Turkey | MEDA |
|---|---|---|---|---|---|---|---|---|---|
| Number of | 2010 | 227 | 596 | 277 | 10.0 | 73.0 | 56.0 | 263 | 1502 |
| listed companies | 2020 | 240 | 426 | 240 | 10.0 | 75.0 | 80.0 | 371 | 1442 |
| | Δ | 13.0 | −170 | −37.0 | 0.00 | 2.00 | 24.0 | 108 | −60.0 |
| | $\mu$ | 242 | 474 | 223 | 10.0 | 74.0 | 73.0 | 318 | 1414 |
| | $\sigma$ | 9.00 | 63.0 | 28.0 | 0.00 | 1.00 | 10.0 | 67.0 | 178 |
| Market | 2010 | 84.3 | 228 | 30.9 | 12.7 | 69.2 | 10.7 | 302 | 738 |
| capitalization[(a)] | 2020 | 41.4 | 262 | 18.2 | 6.70 | 65.6 | 8.57 | 238 | 640 |
| | Δ | −42.9 | 34.0 | −12.7 | −6.00 | −3.60 | −2.10 | −64.0 | −97.3 |
| | $\mu$ | 53.3 | 212 | 24.8 | 10.2 | 59.2 | 8.93 | 217 | 585 |
| | $\sigma$ | 14.0 | 31.8 | 3.19 | 1.80 | 7.00 | 0.68 | 49.3 | 108 |
| Stock | 2010 | 37.2 | 108 | 8.60 | 1.88 | 6.10 | 1.86 | 403 | 567 |
| traded[(a)] | 2020 | 16.1 | 105 | 1.47 | 0.23 | 3.61 | 0.53 | 869 | 996 |
| | Δ | −21.1 | −3.00 | −7.13 | −1.65 | −2.49 | −1.33 | 466 | 429 |
| | $\mu$ | 17.3 | 68.3 | 3.25 | 0.58 | 3.73 | 0.92 | 406 | 500 |
| | $\sigma$ | 7.52 | 19.0 | 1.83 | 0.46 | 0.85 | 0.44 | 149 | 179 |
| Turnover | 2010 | 44.2 | 47.6 | 27.9 | 14.8 | 8.82 | 17.2 | 133 | 42.0 |
| ratio[(b)] | 2020 | 38.9 | 39.9 | 8.09 | 3.47 | 5.50 | 6.21 | 366 | 66.8 |
| | Δ | −5.30 | −7.70 | −19.8 | −11.3 | −3.32 | −11.0 | 233 | 24.9 |
| | $\mu$ | 32.6 | 32.5 | 12.6 | 5.36 | 6.35 | 10.2 | 192 | 41.6 |
| | $\sigma$ | 6.82 | 8.78 | 5.25 | 3.10 | 0.93 | 2.86 | 63.8 | 13.1 |

Note: Data from Algeria, Libya, and Syria are not available or complete over the period. (a) US$ billions and (b) is, technically, the value of the Electronic-Order-Book (EOB) shares traded divided by the market capitalization, annualized by multiplying the monthly average by 12 months. Percent values and MEDA on average are also shown.

On one hand, the capital markets motivate people to invest in financial assets or preserve their money; on the other hand, these make it simple for firms to obtain long-term funding for their investments.

However, the volatility of the capital markets deserves attention by academics, scholars, and specialists. It is well known that big and small investors have suffered significant wealth losses during times of acute market downfall. In fact, policy makers, analysts, and scholars have always had severe concerns about the capital markets. They are frequently referred to as the barometer of the economy because they show how an economy is changing and moving along its development-path. Capital market volatility and movement usually reflect the state of development of any economy. As a result, understanding Islamic financial institutions in general and MEDA capital markets may help investors and analysts to better manage their finances, influencing their invest decisions, and provide assistance to younger generations (Uroqova, 2024; Anisa and Fajri-AF, 2024).

Regarding the size of the MEDA capital markets, some considerations can be traced based on turnover ratio. This is the value of domestic shares traded divided by market capitalization encompassing all the value created in the capital markets, which, in addition to measuring stock exchange liquidity, can be interpreted as an indirect proxy for the average annual yield of capital. In fact, the efficient capital markets are closely related to the overall level of countries' economic development.

Furthermore, the banking and financial system can enhance growth. By encouraging informed investment decisions, pressuring managers to work harder to increase shareholder value, facilitating investor global risk diversification, luring foreign portfolio investment, efficiently directing savings to firms, and enhancing financial asset liquidity, capital markets can hasten MEDA countries' economic growth. In other words, capital markets are significant for countries' economic development because they are pivotal in transferring domestic and foreign savings from the surplus to the deficit economic activities.

Well-functioning and efficient capital markets provide good and easily accessible information that can lower transaction costs by improving economic resource allocation and boosting growth. At low levels of economic development, commercial banks tend to dominate the financial system, while at higher levels, domestic financial markets tend to become more active and efficient relative to the banking system. Open economies with sound governance and functioning rule of law attract more capital and have larger capital markets. Modern communications technology and increased integration of financial markets have resulted in more cross-border capital flows, a stronger presence of foreign firms into the countries, and the migration of assets to foreign markets. Many firms in developing and emerging economies now cross-list on international exchanges, which can provide them with lower cost capital and more liquidity-traded shares. However, this also means that capital markets of these economies may not have enough liquidity to sustain firms' financial activities, finally putting pressure on countries' governance to create sound institutional and business environments.

Despite the importance of previous studies, most have focused on the capital markets of the developed countries, which are advanced enough and do not suffer from the inefficiencies in less developed countries (Lahmiri, 2013; Degutis and Novickytė, 2014; Ţiţan, 2015; Naseer and Bin-Tariq, 2015; Rossi,2015; Bahmani-Oskooee et al., 2016; Yildirim, 2017; Brown, 2020). The efficient market hypothesis (EMH) is highly controversial and its validity is often disputed.

Our research aim of this study is to explore the legitimacy of the EMH in MEDA transitional economies from a macroeconomic perspective, which, to our knowledge, has not been studied for this cluster of countries. Therefore, the subject of capital markets in MEDA transitional economies needs lengthy analysis and more attention. Amid several controversies surrounding the EMH, we provide preliminary and exploratory evidence that the MEDA capital markets are in weak form inefficient.

In this empirical study, we initially considered seven MEDA capital markets: Egypt, Israel, Jordan, Lebanon, Morocco, Tunisia, and Turkey. We explored data from the World Bank database, but tested

the EMH only for five MEDA capital markets, in which annual data on market returns were complete: Egypt, Israel, Jordan, Morocco, and Turkey.

The observations involved 2010–2020 (Visaggio, 2024). Descriptive and serial correlation analyses, the unit root tests, variance ratio, Hurst exponent, and AR(1) models have been used in testing the hypothesis that MEDA capital markets follow a random walk. In compliance with the macroeconomic perspective we adopted, the turnover ratio was chosen as an indirect proxy for market return and was used in computing the market spread ($S_m$), alternatively to the more conventional variation of the market index, thus encompassing all the values created in the capital markets (Peterkort and Nielsen, 2005; Aras and Yilmaz, 2008; Smith, 2008; Shaik and Maheswaran, 2017; Riyath and Jahfer, 2018; Ying et al., 2019; Bhattacharya et al., 2019; Kelikume et al., 2020; Bakri et al., 2020; Naik and Reddy, 2021; Chikwira and Mohammed, 2023; Satapathy, 2025).

The remaining part of the work has been organized as follows: (i) Related literature, (ii) empirical analysis, and (iii) conclusions.

## 2. Related literature

### *2.1. The efficient market hypothesis theory*

The efficient market hypothesis (EMH) is one of the most important theories for the efficient functioning of capital markets. The EMH theory highlights that the time series of returns have no memory. This means that traders and investors cannot obtain extraordinary capital gains in financial markets through suited arbitrage strategies. Different seminal contributions have analyzed the EMH in capital markets by examining the forecast ability of financial markets through the decomposition of the dividend yields and expected returns (Fama and French, 1988). This theory indicates several necessary conditions for efficient capital markets: (i) Markets are frictionless, meaning that there are no transactions cost or taxes in an liberal economy, whole assets are completely divisible, marketable, and there are no restrictions on trade; (ii) there exists perfect competition in the markets and the agents are price takers; (ii) the information attained is costless and it is received in the same time by all individuals; and (iv) all individuals are rational and maximize the utility.

Therefore, from this perspective, Malkiel and Fama (1970) designed the EMH following the information theory. According to the EMH theory, when investors face new information, they can overreact, or some may underreact to a given situation. In this framework, investors' reactions follow a random behavior and can be traced with a normal distribution pattern, so that the net effect on market prices may not be reliably explored to make an abnormal profitable situation if transaction costs are known. The theory also distinguishes different forms of the EMH, based on a more thorough understanding of what is relevant information: (i) Strong form, market prices contain all information, publicly open and insider; (ii) half–strong form, market prices contain all publicly available information; and (iii) weak form, the market price of an investment includes all information about the price history of that investment.

Although it is possible to test the strong form and half–strong form in the EMH, the weak form is the least problematic to test. Reasonable objections against testing the EMH in weak-form does not exist. In fact, this situation may be perceived by investors in a wrong manner (Copeland et al., 2005; Angelini and Guazzarotti, 2010). When the capital markets work efficiently, the prices show the intrinsic values of the equity, and in reply, the limited savings will be allocated to the productive

investment sector optimally in such a way that will provide stream of benefits to investors and the country's economy as a whole (Mäkinen, 2014).

Subsequently, Rubinstein (1975) and Latham (1985) extended the theoretical basis of efficient markets. According to these authors, markets are efficient regarding available information when the latter does not change investors' portfolio preferences. Therefore, agents may not be agreeing with the given conjectures, so some may buy an asset and others may sell, in such a way that the market price is not affected. If the available information does not change portfolio preferences, then the market is termed efficient, according to the information theory (Fama, 1991).

Numerous issues in various aspects have been raised about this theoretical framework, but the EMH has remained popular for the last three decades. In fact, the regulatory authorities have tried to consider the best policy and practices regarding decreasing market interferences to the minimum level. When there are gaps in the market information and efficiency, outstanding returns can be realized. In other words, the legitimacy of the existence of random-walk hypothesis (Kendall and Hill, 1953) is significant in theories about the capital mobility and financial market, as well as in investment decisions. Traditional financial models can assume that returns are normally distributed. In these models, the normality assumption over return series simplifies the risk analysis, making it feasible to forecast volatility and implement mean–variance optimization algorithms.

Therefore, EMH is a significant topic for academics, investors, and other stakeholders. The random-walk hypothesis is based on two assumptions: (i) The current price of a savings bond reflects all available information, indicating that the price movements over time are a series of random numbers, so the serial correlation of errors is equal to zero; and (ii) price changes obey the same probability distribution. On the other hand, if capital markets are inefficient, the pricing apparatus may not assure the efficient capital allocation in an economy where there are overall worse socioeconomic outcomes. As economic growth is related to the growth in the capital market, developing countries depend on the accuracy of the set of information. In the presence of asymmetric information, the fluctuations in the capital market would have serious harmful consequences on the countries' economy.

### *2.2. Empirical literature*

Several authors have tested the EMH in developing and emerging economies. For instance, Nisar and Hanif (2012) analyzed Southern Asia capital markets over the period 1997–2011 and rejected the EMH, suggesting that these capital markets are inefficient in weak–form. Moreover, Mehla and Goyal (2012) and Malafeyev et al. (2019) examined Indian and Chinese capital markets, finding that they did not respect the EMH. Mohti et al. (2018) showed through comparative analysis that the most efficient capital markets were the Western ones, while the least efficient ones were in the Middle East. However, Caporale et al. (2020) analyzed returns in European capital markets of five advanced economies and highlighted how the presence of long memories in the time series could weaken the EMH. Milos et al. (2020) instead examined seven capital markets in Central and Eastern Europe, revealing that time-series of returns showed long–term correlations, thus not supporting the EMH.

Alternatively, Abraham et al. (2002) studied MENA markets. They argue that index in thinly traded equity markets may not embody the true index value. Thus, there was a systematic bias towards rejecting the EMH. Moreover, the capital markets show infrequent trading, which has changed the results of market efficiency and random-walk tests.

Lagoarde-Segot and Lucey (2008) showed heterogeneous levels of efficiency in MENA capital markets. The explaining power of some factors such as market depth and corporate governance on the efficiency has been identified in capital markets. Rejichi and Aloui (2012) examined the evolving efficiency of MENA capital markets by applying the Hurst exponent during that time. Their results have shown that all MENA capital returns represent long-range memory, and certain markets are becoming more efficient. Some of the markets in countries like Turkey and Egypt are less efficient than the others in the region. They also state that some variables such as average trading cost, market capitalization, and the anti–self–dealing index play a role in describing these differences in the stage of inefficiency across MENA capital markets.

Sensoy (2013) investigated MENA capital markets and found that Tunisia and Iran seem to be the most inefficient markets, whereas the Turkey capital market was the least inefficient one. Moreover, he found that "Arab spring" riots have had a negative impact on the MENA markets efficiency. Saeedi et al. (2014), by applying autocorrelation, augmented Dickey-Fuller and ran tests showing that the findings of all tests do not back that capital returns pursue a random walk. They concluded that it is possible to use the technical skills to get the abnormal gains. Interestingly, El-Khamlichi et al. (2014) tested Islamic stock exchange indices and compared them with a benchmark, showing that these indices have a similar efficiency degree to the benchmark, with some of these indices being more efficient. Assaf and Charif (2017) also analyzed several MENA capital markets, finding that they approached weak-form efficiency.

Charfeddine and Khediri (2016) tested for the weak form efficiency of the GCC capital markets using different techniques. They argued that not only do these capital markets have various degrees of time–varying efficiency, but they also are characterized by periods of efficiency improvements. They also showed that the "Arab Springs" and global economic crisis have affected the time path evolution of market efficiency. Ngene et al. (2016) examined several capital markets that exhibited structural breaks in the return time–series, concluding that they were consistent with the EMH.

Al-Shboul and Alsharari (2019) examined the dynamic behavior of market efficiency in the UAE markets by considering the advent of the global economic crisis, the "Arab Springs" riots, and the oil prices crisis. They found that the UAE capital markets are characterized by evolving efficiency. They also found that shocks resulting from crises do not affect the dynamic behavior of market efficiency.

While Worthington and Higgs (2004) investigated developed European countries by applying the serial correlation test, running the test for random-walk, augmented Dickey-Fuller test for the time-series stationarity, and variance ratio test. They argue that all indices are not normally distributed, and only some countries fulfill the sternest criteria for random-walk. Similarly, Borges (2010) provided evidence that capital returns are abnormally distributed with negative skewness and leptokurtic for European developed countries. Hamid et al. (2010) tested the EMH for a cluster of Asia–Pacific developed and developing economies, finding that capital returns do not follow random patterns across all countries in their cluster. Azad et al. (2014) also studied the weak form of market inefficiency in emerging markets in South Asia, concluding that South-Asian markets are inefficient in the weak-form. Akgun and Sahin (2017) investigated the EMH for the Turkish capital market, while Lekhal and El-Oubani (2020) investigated the EMH for the Moroccan capital market.

Moreover, Kelikume et al. (2020) investigated the weak axiom of the EMH in some African capital markets adopting the wavelet unit root analysis tool, and they found that institutional constraints have implications for the EMH and investment in the African capital markets. Ananzeh (2021) rejected the EMH at a weak-form for Arab markets analyzed. Their results contradict those of many studies conducted on developed and developing countries. Furthermore, Elangovan et al. (2022) found that Indian capital market indices do not follow a random-walk and the market is weak-form inefficient.

El-Diftar (2024) employed both parametric and non-parametric statistical techniques and found that sampled capital markets are not efficient; hence, investors may take advantage of these markets in generating tremendous profits. He also showed that there are variations of efficiency and that some of these markets are closer to being efficient and less predictable than others. Relevance has also been given to the interconnections among the national stock exchanges, especially by analyzing periods of financial turmoil (Öztürk-Savaş and Çetin, 2025).

In conclusion, there are numerous researchers testing the EMH in developed countries, but there are not enough researchers testing the random–walk of capital market indices in developing countries; and there are none specially for the MEDA transitional economies. As a result, we also contribute to the economic literature on the effects of the Covid-19 global pandemic crisis on capital markets from the macroeconomic perspective (WEF, 2020; Alfaro et al., 2020; Baker et al., 2020; Ding et al., 2021; Ramelli and Wagner, 2020; Dias et al., 2020; Guerrieri et al., 2022).

## 3. Empirical analysis

### *3.1. Materials, methods, and instruments*

We set our research hypothesis ($H_0$) as follows: Do MEDA capital markets follow random-walk? The observations encompass annual average values of the turnover ratio ($\pi$) for time-series data from 2010 to 2020. This is a less conventional index in the empirical studies; nevertheless, it is an average measure of all the values created in the capital market. Moreover, turnover ratio is positively associated with aspects of market development, such as economic growth and lower cost of capital, reflecting pricing information (Peterkort and Nielsen, 2005; Aras and Yilmaz, 2008; Smith, 2008; Shaik and Maheswaran, 2017; Riyath and Jahfer, 2018; Ying et al., 2019; Bhattacharya et al., 2019; Kelikume et al., 2020; Bakri et al., 2020; Naik and Reddy, 2021; Chikwira and Mohammed, 2023; Satapathy, 2025). This means that turnover ratio can indirectly reflect a higher information flow for efficient price discovery. For example, an increased market liquidity can indicate an improved market infrastructure facilitating the information flow. Furthermore, index value's sudden spikes can be linked to disagreement among investors, market sentiment swings, or other market failures and inefficiencies.

To test the EMH, the market spread ($S_m$) was computed as $S_m = \pi_t / \pi_{t-1}$ over the period 2011–2020 for five MEDA capital markets with complete time series: Egypt, Israel, Jordan, Morocco, and Turkey.

We used different classical statistical approaches and tests, similarly to other authors with reference to this topic: (i) The descriptive analysis of kurtosis and skewness; (ii) normality tests, such as the *D*-statistic of Kolmogorov-Smirnov and the *W*-statistic of Shapiro and Wilk; (iii) the AC and APC for serial correlation analysis; (iv) the *Q*-statistic of Ljung-Box; (vi) unit root tests, such as the Augmented Dickey-Fuller (ADF), the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests, and the Quandt-Likelihood Ratio (QLR) test to check for possible structural breaks in time series; (vii) the Lo and MacKinlay variance ratio test for $q = 2, 5$; (viii) the Hurst exponent computed with the more robust modified R/S statistic; and (ix) the AR(1) regressions estimated by exact maximum likelihood.

The statistical software used was the open source gretl. The rationale behind using these approaches and tests were: (i) EMH requires the normality assumption and the absence of serial correlation of $S_m$ series over time, hence the need for normality and autocorrelation tests; (ii) EMH requires that time series are stationary, thus emphasizing the need for unit root tests; (iii) under conditions of infrequent market trading, as is likely in transitional or emerging economies, testing the EMH require that $S_m$ series follow

a random-walk path, thus the need for either the conventional Lo and MacKinlay test, the computation of Hurst exponent with the more robust modified R/S statistic; and (iv) the AR(1) models have been implemented in testing the significance of the lag of the dependent variable.

We avoid reporting here an extensive mathematical formalization in order not to weigh down our work. However, we refer to the specialized statistical and econometric literature and to that produced by the authors of the various tests (see: Kolmogorov, 1933; Smirnov, 1948; Quandt, 1960; Shapiro and Wilk, 1965; Ljung and Box, 1978; Dickey and Fuller, 1979; Lo and MacKinlay, 1988; Lo, 1991; Kwiatkowski et al., 1992; Campbell et al., 1997; Davidson, 2018).

Particularly, we reported only the interpretation of the Ljung-Box *Q*-statistics, the Augmented Dickey-Fuller and KPSS unit roots tests, the Lo and MacKinlay variance ratio test, and the Hurst exponent estimated via OLS because we consider them significant for the continuation of the analysis.

The Ljung-Box *Q*-statistic assumes, as a null hypothesis, that all serial correlations are equal to zero. Specifically, the absence of autocorrelation in successive series is an important indication of randomness in time-series. As a result, a significant *Q*-statistic rejects the null and indicates that there is predictability in future outcomes or that series or do not follow a random-walk (inefficient in weak-form). The advantage of this approach is its finite sample correction ability by providing a superior fit because the $\chi^2$–distribution is used.

Given that a random-walk path requires the presence of a unit root in the series (non-stationarity assumption), the Augmented Dickey-Fuller and KPSS tests have been implemented. The ADF test assumes that series follows an autoregressive process AR($p$) with the null hypothesis that the coefficient is equal to zero versus the alternative that it is greater than zero. Additionally, the KPSS test has been implemented because it has the advantage of being designed to test the null hypothesis of stationarity, and the unit root presence is the alternative.

The Lo and MacKinlay variance ratio test has the advantage good finite sample properties and being sensitive to autocorrelation.

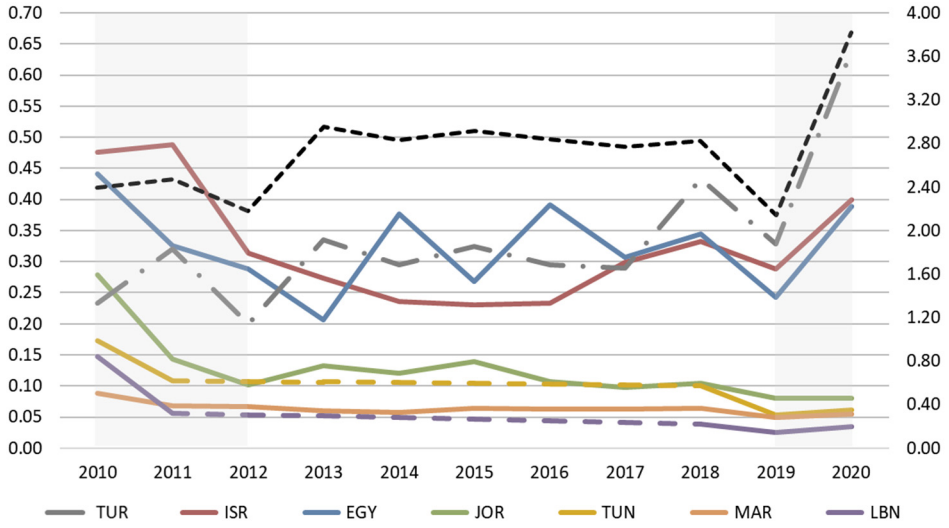
Finally, in computing the Hurst exponent ($H_e$), the more robust modified R/S statistic (Lo, 1991) has been implemented (Mynhardt et al., 2014). The index is defined in the (0,1) interval, and can be classified as follows: (i) $0 \leq H_e < 0.5$, the EMH is not confirmed, the distributions have fat tails, the series are anti–persistent, and the $S_m$ series are negatively correlated; (ii) $H_e = 0.5$, the EMH is confirmed, the $S_m$ series follow a random Brownian motion, series are uncorrelated, there are no memory in the series, and traders cannot "beat" markets by using a trading strategy; and (iii) $0.5 < H_e \leq 1$, the EMH is not confirmed, the distributions have fat tails, the series are persistent, the $S_m$ series are positively correlated, and there is a significant trend in the markets.

### *3.2. Outcomes and interpretation*

In Figure 1, trends show that π-values are moving cumulatively in a systematic manner. After the "Arab Springs" riots, the performances of all MEDA capital markets collapsed. Morocco was an exception and remained stable.

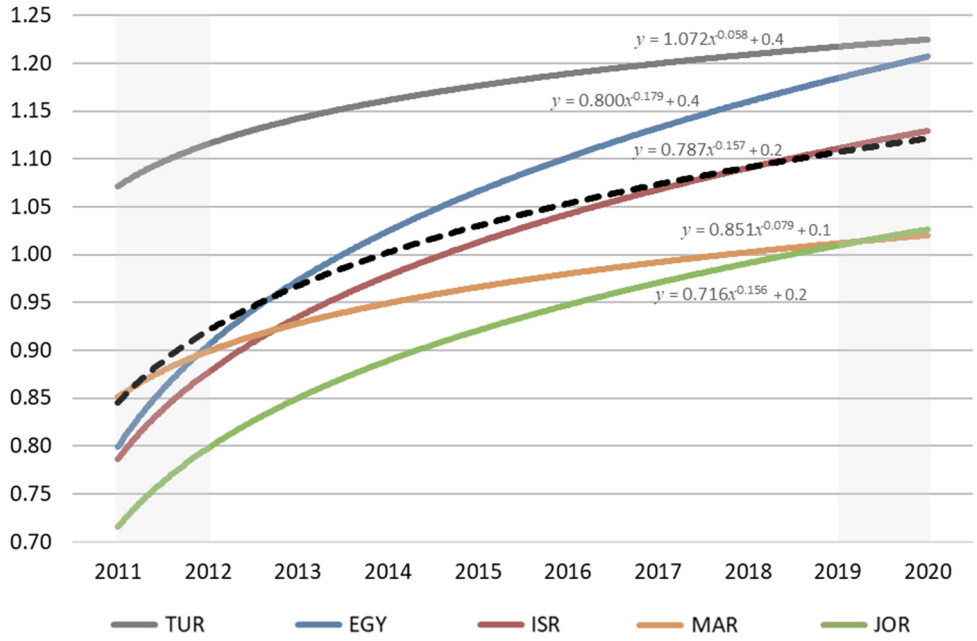
The Egyptian and Israeli performances have continued to fall, and the recoveries have been slowed. Only Turkey is above the MEDA benchmark. Furthermore, the global pandemic crisis began in 2020, but the performance of all MEDA capital markets has surprisingly improved (Kamal, 2014; Chambino et al., 2023; Saad and Faouzi, 2024; Asaad and Omer, 2024; Belhoula et al., 2024).

Figure 2 shows the trends for the performance of each MEDA capital market, the interpolating functions, and the speed at which they yearly grow. For all series, this magnitude is very low, suggesting that $S_m$ series are substantially chaotic or unpredictable and that series are reverted or oscillating. Overall, Turkey was consistently above the MEDA average; Egypt was the second-best performing MEDA capital market; Israel followed the benchmark; and Morocco and Jordan performed the worst and were aligned in the end.




Note: (a) Turkey follows the values in the second axis; (b) in gray bars the "Arab Springs" upheaval and the global pandemic crisis; and (c) MEDA as benchmark in the black broken line, from 2012 to 2017 Lebanon and Tunisia were omitted due to missing values in their series.

**Figure 1.** Trends of turnover ratio (π) of the MEDA capital markets.




Note: (a) In gray bars, the "Arab Springs" upheaval and the global pandemic crisis; (b) MEDA as benchmark in the black broken line; and (c) Lebanon and Tunisia are omitted due to missing values in their series.

**Figure 2.** The interpolated $S_m$ series of the MEDA capital markets.

Table 3 shows the descriptive statistics of the $S_m$ series for only the five MEDA capital markets with complete data. Descriptive statistics have included the median value, arithmetic mean, standard deviation, variation coefficient, skewness, kurtosis, and range. Finally, the *W*-statistic of Shapiro and Wilk and the non-parametric *D*-statistic of Kolmogorov-Smirnov test the normality distribution of time-series (Razali and Wah, 2011).

**Table 3.** Descriptive statistics for the $S_m$ series of the MEDA capital markets.

| | Egypt | Israel | Jordan | Morocco | Turkey |
|---|---|---|---|---|---|
| Median | 0.835 | 0.996 | 0.911 | 0.982 | 1.042 |
| Mean | 1.056 | 1.004 | 0.912 | 0.960 | 1.175 |
| Standard Deviation | 0.426 | 0.216 | 0.235 | 0.114 | 0.431 |
| Min | 0.703 | 0.643 | 0.515 | 0.772 | 0.622 |
| Max | 1.826 | 1.384 | 1.314 | 1.104 | 1.946 |
| Variation Coefficient | 0.404 | 0.215 | 0.257 | 0.119 | 0.367 |
| Skewness | 0.774 | 0.259 | 0.053 | −0.512 | 0.491 |
| Kurtosis | −1.006 | −0.462 | −0.652 | −0.720 | −0.962 |
| Range | 0.787 | 0.290 | 0.340 | 0.164 | 0.691 |
| Time unit | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| W–test | 0.812 | 0.962 | 0.989 | 0.903 | 0.945 |
| (p–value) | (0.020) | (0.804) | (0.996) | (0.239) | (0.611) |
| D–test | 0.659 | 0.640 | 0.597 | 0.680 | 0.633 |
| (p–value) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Observations | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

Note: Lebanon and Tunisia are omitted due to missing values in their series.

The series is negatively skewed only for one MEDA capital markets (Morocco), indicating that the minimum extreme value is larger than the maximum extreme value. Moreover, Tunisia and Lebanon are struck by the "Arab Springs" unrests and there are missing values for both series. The kurtosis is negative for all MEDA capital markets. This means that the series are not leptokurtic, indicating lighter tails than the normal distribution. Therefore, the series are not normally distributed.

The Turkish capital market provides the highest $S_m$ (1.2) and has the highest standard deviation (0.43). The Israeli capital market provides a lower $S_m$ (1.0) but with a moderated standard deviation (0.2). However, the lower risk level is in the Moroccan capital market (0.1). This is also consistent with the improved country's macroeconomic conditions and its political stability.

Finally, the *D*-statistic of Kolmogorov-Smirnov widely rejects the null hypothesis of a normal distribution for all MEDA capital markets. Instead, the *W*-statistic of Shapiro and Wilk rejects the null hypothesis for Egypt and widely accepts it for the other MEDA capital markets. However, the sample is very small; therefore, to further analyze the randomness of the $S_m$ series, the serial autocorrelation analysis and *Q*-statistic of Ljung-Box have been implemented. The autocorrelation tests (AC), partial autocorrelation tests (PAC), and *Q*-tests are shown in Table 4. The correlation coefficients and the *Q*-statistics are shown up to the maximum order of lags.

**Table 4.** The autocorrelation values and Q-tests for the $S_m$ series.

| | Lags | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Egypt | AC | −0.556 | 0.409 | −0.523 | 0.327 | −0.349 | 0.379 | −0.091 | 0.012 | −0.107 |
| | PAC | −0.556 | 0.144 | −0.367 | −0.147 | −0.206 | 0.000 | 0.285 | −0.175 | −0.073 |
| | Q-test | 4.125 | 6.634 | 11.33 | 13.46 | 16.39 | 20.70 | 21.04 | 21.04 | 22.43 |
| | (p-value) | (0.042) | (0.036) | (0.010) | (0.009) | (0.006) | (0.002) | (0.004) | (0.007) | (0.008) |
| Israel | AC | 0.063 | 0.116 | 0.158 | −0.117 | −0.246 | −0.165 | 0.004 | −0.334 | 0.021 |
| | PAC | 0.063 | 0.112 | 0.147 | −0.150 | −0.282 | −0.158 | 0.141 | −0.251 | 0.004 |
| | Q-test | 0.053 | 0.254 | 0.681 | 0.954 | 2.401 | 3.213 | 3.214 | 9.922 | 9.974 |
| | (p-value) | (0.818) | (0.881) | (0.878) | (0.917) | (0.791) | (0.782) | (0.865) | (0.271) | (0.353) |
| Jordan | AC | −0.150 | −0.140 | −0.101 | −0.231 | 0.293 | −0.180 | 0.014 | 0.073 | −0.078 |
| | PAC | −0.150 | −0.166 | −0.158 | −0.325 | 0.155 | −0.257 | −0.053 | −0.030 | −0.027 |
| | Q-test | 0.299 | 0.593 | 0.766 | 1.830 | 3.884 | 4.858 | 4.866 | 5.185 | 5.921 |
| | (p-value) | (0.584) | (0.744) | (0.858) | (0.767) | (0.566) | (0.562) | (0.676) | (0.738) | (0.748) |
| Morocco | AC | −0.277 | 0.085 | 0.089 | −0.432 | 0.115 | 0.022 | −0.181 | 0.308 | −0.230 |
| | PAC | −0.277 | 0.009 | 0.124 | −0.414 | −0.136 | 0.108 | −0.140 | 0.050 | −0.150 |
| | Q-test | 1.023 | 1.130 | 1.267 | 4.993 | 5.313 | 5.327 | 6.641 | 12.33 | 18.65 |
| | (p-value) | (0.312) | (0.568) | (0.737) | (0.288) | (0.379) | (0.503) | (0.467) | (0.137) | (0.028) |
| Turkey | AC | −0.576 | 0.336 | −0.093 | −0.139 | 0.168 | −0.391 | 0.409 | −0.305 | 0.092 |
| | PAC | −0.576 | 0.006 | 0.153 | −0.209 | −0.045 | −0.364 | 0.083 | 0.049 | −0.207 |
| | Q-test | 4.419 | 6.108 | 6.258 | 6.645 | 7.320 | 11.90 | 18.59 | 24.19 | 25.20 |
| | (p-value) | (0.036) | (0.047) | (0.100) | (0.156) | (0.198) | (0.064) | (0.010) | (0.002) | (0.003) |

Note: Lebanon and Tunisia are omitted due to missing values in their series.

Negative autocorrelations suggest that sequential $S_m$ values are inversely correlated, showing that values are possibly drifting toward mean values than drifting away.

Positive autocorrelations suggest that sequential $S_m$ values are possibly sustained, indicating that changes in values could carry momentum.

Fundamentally, the null hypothesis for random-walk is rejected if the serial correlation contains the positive coefficients over the different lags. In fact, although there are negative autocorrelations for all MEDA capital markets, different lags have positive values; therefore, we cannot infer that a market is a weak-form efficient.

The results show strong signs of autocorrelation in the $S_m$ series for Egypt and Turkey. The significance of the $Q$-tests across the lags indicates that the EMH in the weak-form in the $S_m$ series does not hold. The null hypothesis of random-walk is rejected, suggesting that the series may exhibit no weak-form market efficiency.

This can be further affirmed for the performance predictability of MEDA capital markets. As a result, this can infer that the historical data may be used to predict future trends. Further analysis requires that the series are stationary or non-stationary.

The ADF-GLS and KPSS tests for unit roots in time-series are shown in Table 5. The unit root tests are applied to check the stationarity as a necessary condition for random-walk. Moreover, the Quandt-LR test automatically detects a structural break in time-series.

**Table 5.** The unit root tests and presence of structural breaks.

| | | ADF-GLS | | KPSS[(a)] | | QLR |
|---|---|---|---|---|---|---|
| | I-order | Constant | Constant and trend | Constant | Constant and trend | Years |
| Egypt | I(0) | −5.751 | −5.639** | 0.098 | 0.052 | 2012 |
| Israel | I(0) | −2.077** | −4.632* | 0.438* | 0.050 | – |
| Jordan | I(0) | −3.979*** | −3.642 | 0.130 | 0.096 | 2013 |
| Morocco | I(0) | −4.405*** | −4.003 | 0.173 | 0.088 | 2016 |
| Turkey | I(0) | −6.329 | −6.821*** | 0.100 | 0.062 | 2018 |

Note: (a) The rejection areas are: *** α = 0.01; ** α = 0.05; and * α = 0.10. Lebanon and Tunisia are omitted due to missing values in their series.

**Table 6.** The variance ratio tests and Hurst exponents.

| | Period | 2[(a)] | 5[(a)] | 2011–2020[(b)] |
|---|---|---|---|---|
| Egypt | VR-Test | 0.302 | 0.471 | |
| | Homoscedasticity | −2.208** | −0.764 | |
| | Heteroscedasticity | −2.524** | −0.905 | |
| | Hurst Exponent | | | 0.463*** |
| Israel | VR-Test | 1.100 | 1.710 | |
| | Homoscedasticity | 0.315 | 1.024 | |
| | Heteroscedasticity | 0.611 | 2.076** | |
| | Hurst Exponent | | | 0.111 |
| Jordan | VR-Test | 0.909 | 0.751 | |
| | Homoscedasticity | −0.289 | −0.360 | |
| | Heteroscedasticity | −0.605 | −0.526 | |
| | Hurst Exponent | | | 0.585*** |
| Morocco | VR-Test | 0.637 | 0.908 | |
| | Homoscedasticity | −1.149 | −0.133 | |
| | Heteroscedasticity | −1.992** | −0.249 | |
| | Hurst Exponent | | | 0.394*** |
| Turkey | VR-Test | 0.269 | 0.500 | |
| | Homoscedasticity | −2.312** | −0.721 | |
| | Heteroscedasticity | −2.455** | −0.906 | |
| | Hurst Exponent | | | 0.404*** |

Note: The rejection areas (a) / significance for (b): *** α = 0.01; ** α = 0.05; and * α = 0.10. Lebanon and Tunisia are omitted due to missing values in their series.

The results of the ADF-GLS test shows that p-values in the two variants with constant and trend are below the usual significance levels. This implies that series are stationary at the integration order I(0); therefore, the null hypothesis of unit root is rejected in both variants.

Given the brevity of our time-series, we point out that, generally, economic data in a level may hide a unit root while showing stationarity. In fact, unit root tests imply that the error terms in the regressions are white noise, but the EMH does not necessarily require the confirmation of white noise (resulting in an assumption that is too strong), but only the presence of a random-walk (namely zero

mean uncorrelated). As a result, the property of being stationary at the integration order I(1) may not necessarily indicate the presence of weak or non-weak efficiency.

However, the weak-form EMH requires a random walk in the returns. Therefore, the series should show non-stationarity. As confirmation for the time-series stationarity, the KPSS test for cross-validation was implemented. We found that the $S_m$ series of Egypt, Israel, and Turkey are stationary with constant and trend, whereas the series of Jordan and Morocco are stationary only with the constant.

Finally, the QLR test shows the different years in which $S_m$ series have had a significant structural break. Unit root tests may not uniformly detect departures from a random-walk, and they may be insufficient for testing the EMH.

The Lo-MacKinlay variance ratio (VR) test is useful to examine the predictability of capital markets. Additionally, by using the more robust Lo' modified R/S test, the Hurst exponent is also computed throughout the period (Table 6).

The VR-test is conducted by testing for periods two and five, given the shortness of time series. The results are shown under the two assumptions of homoscedasticity and heteroscedasticity, respectively.

The outcomes are mixed. The individual variance ratios diverge from the theoretical value of one (random-walk) in all MEDA capital markets. Jordan is near to the theoretical value in period two and far away in period five; Morocco does the opposite. This evidence may be consistent with the sounder and developed Moroccan institutional and business environment (Scalamonti, 2024). In fact, the country has not been subjected to noteworthy socioeconomic shocks and has not experienced wars and significant upheavals like Jordan.

The VR-test under the homoscedasticity and heteroscedasticity assumptions is significant for Egypt, Morocco, and Turkey at period two, while it is significant for Israel at period five. As a noteworthy observation, the variance ratio increases with increasing period; thus, the statistics also tend to increase and the significance of the rejection may become stronger. Furthermore, the VR-test rejects the random-walk path hypothesis and indicates the presence of deviation and autocorrelation in the series. When the VR-test is greater than one, the series is positively correlated; otherwise, it is negatively correlated. Finally, the VR-test results are also supported by the estimated Hurst indices.

The indices for Egypt, Morocco, Israel, and Turkey are below 0.5, indicating an anti-persistent motion in the series and negatively correlated values. The indices for Egypt and Turkey are higher and nearest to 0.5, and, hence, to a Brownian motion without memory in the series. In fact, this evidence may be consistent with long-established capital markets.

The Hurst index for Jordan is below 0.5, indicating a long-range persistence in the series and positively correlated values. In general, the VR-test and the Hurst exponent suggest that MEDA capital markets may exhibit inefficiency over the period 2011–2020.

Our analysis in testing the EMH in MEDA capital markets concludes with the estimation of AR(1) models for the time series, with which the significance of the dependent variables with one order of lags was checked. The outcomes are shown in the Table 7.

In particular, the dependent variables with one order of lags are significant for Egypt and Turkey, but not for the other markets. Nevertheless, the negative coefficients are contributing to explain $S_m$ trends, suggesting possible inefficiencies in the markets. In MEDA capital markets, where the lagged dependent variable is non-significant, may indicate the presence of exogenous confounding factors shaping the $S_m$ trends more than the same lagged dependent variable, likely related to the countries' institutional and business environment, such as the impacts of governance climate, information disclosure, management liability, shareholder protection, economic freedom, and financial

liberalization. This is consistent with the macroeconomic conditions and institutional environments of Morocco, Israel, and Jordan. In fact, financial markets' development and depth are conditional on the level of governance quality (Dal Bianco et al., 2017).

**Table 7.** AR(1) models.

| | Market Spread ($S_m$) | | | | |
|---|---|---|---|---|---|
| | EGYPT | | | | |
| | Coeff. | Z-test | Std. Err. | 95% Conf. Int. | |
| Market Spread $(S_m)_{t-1}$ | −0.639*** | –2.667 | 0.240 | –1.109 | –0.169 |
| Time-Trend | 0.021 | 0.913 | 0.023 | –0.024 | 0.067 |
| Constant | 0.908*** | 5.625 | 0.161 | 0.592 | 1.225 |
| Standard Error | 0.299 | | | | |
| $R^2$ | 0.457 | | | | |
| \| Root \| > 1 | 1.564 | | | | |
| Residuals Normality Test | 1.525 | | | | |
| (p-value) | (0.466) | | | | |
| Interactions | 10 | | | | |
| Observations | 10 | | | | |
| | ISRAEL | | | | |
| | Coeff. | Z-test | Std. Err. | 95% Conf. Int. | |
| Market Spread $(S_m)_{t-1}$ | −0.511 | –1.613 | 0.317 | –1.132 | 0.110 |
| Time-Trend | 0.045*** | 3.900 | 0.012 | 0.023 | 0.068 |
| Constant | 0.696*** | 8.505 | 0.082 | 0.536 | 0.856 |
| Standard Error | 0.143 | | | | |
| $R^2$ | 0.521 | | | | |
| \| Root \| > 1 | 1.957 | | | | |
| Residuals Normality Test | 1.011 | | | | |
| (p-value) | (0.603) | | | | |
| Interactions | 10 | | | | |
| Observations | 10 | | | | |
| | JORDAN | | | | |
| | Coeff. | Z-test | Std. Err. | 95% Conf. Int. | |
| Market Spread $(S_m)_{t-1}$ | −0.171 | –0.488 | 0.350 | –0.857 | 0.516 |
| Time-Trend | 0.017 | 0.768 | 0.022 | –0.026 | 0.059 |
| Constant | 0.808*** | 5.206 | 0.155 | 0.504 | 1.113 |
| Standard Error | 0.212 | | | | |
| $R^2$ | 0.100 | | | | |
| \| Root \| > 1 | 5.856 | | | | |
| Residuals Normality Test | 0.723 | | | | |
| (p-value) | (0.697) | | | | |
| Interactions | 13 | | | | |
| Observations | 10 | | | | |
| | MOROCCO | | | | |
| | Coeff. | Z-test | Std. Err. | 95% Conf. Int. | |

| | | | | | |
|---|---|---|---|---|---|
| Market Spread $(S_m)_{t-1}$ | −0.378 | –1.076 | 0.352 | –1.068 | 0.311 |
| Time-Trend | 0.009 | 0.988 | 0.009 | –0.009 | 0.026 |
| Constant | 0.904*** | 14.40 | 0.063 | 0.781 | 1.027 |
| Standard Error | 0.096 | | | | |
| $R^2$ | 0.226 | | | | |
| \| Root \| > 1 | 2.642 | | | | |
| Residuals Normality Test | 1.946 | | | | |
| (p-value) | (0.378) | | | | |
| Interactions | 8 | | | | |
| Observations | 10 | | | | |
| | TURKEY | | | | |
| | Coeff. | Z-test | Std. Err. | 95% Conf. Int. | |
| Market Spread $(S_m)_{t-1}$ | −0.846*** | –4.971 | 0.170 | –1.179 | –0.512 |
| Time-Trend | 0.022 | 1.260 | 0.017 | –0.012 | 0.055 |
| Constant | 0.986*** | 8.247 | 0.120 | 0.751 | 1.220 |
| Standard Error | 0.247 | | | | |
| $R^2$ | 0.639 | | | | |
| \| Root \| > 1 | 1.182 | | | | |
| Residuals Normality Test | 3.286 | | | | |
| (p-value) | (0.193) | | | | |
| Interactions | 13 | | | | |
| Observations | 10 | | | | |

Note: *** is significant for α = 0.01; ** is significant for α = 0.05; and * is significant for α = 0.10. Lebanon and Tunisia are omitted due to missing values in their series.

### *3.3. Interpretative summary of the results*

The results from the above tests and regressions to confirm the EMH in MEDA capital markets are summarized in Table 8.

**Table 8.** MEDA capital markets and random-walk.

| | Kurtosis | Kolmogorov-Smirnov D-test | Serial Correlation | Ljung-Box Q-test | Unit Root Test | Lo-MacKinlay VR–test | Hurst Exponent | AR(1) Model | Efficient Market Hypothesis |
|---|---|---|---|---|---|---|---|---|---|
| Egypt | NO | NO | NO | NO | NO | NO | NO | NO | Rejected |
| Israel | NO | NO | NO | YES | NO | NO | NO | NO | Rejected |
| Jordan | NO | NO | NO | YES | NO | NO | NO | NO | Rejected |
| Morocco | NO | NO | NO | YES | NO | NO | NO | NO | Rejected |
| Turkey | NO | NO | NO | NO | NO | NO | NO | NO | Rejected |

Note: Lebanon and Tunisia are omitted due to missing values in their series.

The interpretative summary of results indicates that none of the MEDA capital markets in question completely follow the random-walk hypothesis, and therefore they remained inefficient over the period analyzed. It is worth highlighting that the rejection or acceptance of the EMH here does not essentially

entail that MEDA capital markets are efficient or inefficient, because these conclusions are substantially based on only one aggregate macro-indicator over a limited period, which may also hide a possible composition effect. In fact, we recognize that with few per-country observations, our tests and results may have limited statistical and explicative power, and that $S_m$ series may be stationary in levels for this reason; although, in some cases, they have showed a structural break. Nevertheless, our study provided noteworthy preliminary and exploratory evidence regarding the EMH in weak-form for MEDA capital markets and is worthy of further investigation.

## 4. Conclusions

### *4.1. Contribution and concluding remarks*

We aimed to investigate the efficiency of a group of five MEDA capital markets (Egypt, Israel, Jordan, Morocco, and Turkey) over the period 2010–2020 according to the efficiency markets hypothesis (EMH) in the weak-form, also known as the random-walk theory, adopting a macroeconomic perspective in providing preliminary and exploratory evidence. The less conventional turnover ratio in computing $S_m$ was employed, thus encompassing all the values created in the capital market than the more conventional market index that encompasses only one part of the value created in the financial market.

The study was carried out due to conflicting results of previous studies referring to MEDA capital markets, as well as due to their importance, since MEDA countries are placed in the Mediterranean Basin, and the movement of capital between them and European markets. In fact, since the early 1990's, many MEDA countries, and overall Arab countries, have embarked on significant financial and economic reforms, involving internal and external financial liberalization, as well as efforts to increase the depth, scope, and efficiency of their capital markets (Cortina et al., 2018).

We reject the EMH in the weak-form for all MEDA capital markets. In other words, MEDA capital markets are inefficient in the weak-form, at least according to our preliminary results.

In fact, the fundamental prerequisite of the EMH is that returns must follow a random-walk and therefore should be unpredictable. We conclude that $S_m$ series do not follow random-walks in the five MEDA capital markets analyzed. As a result, domestic and foreign investors can take the stream of benefits through the arbitrage process from profitable opportunities through portfolio investments (Moro and Schiavone, 2022). Overall, the results suggest that the extent of weak–form efficiency in the MEDA capital markets can be primarily explained by differences in market size and institutional and business environments.

Our results can be consistent with those of previous studies reporting the weak-form inefficiency for the MEDA capital markets analyzed, despite the best efforts made by MEDA countries' governance to update many legislations related to stimulating capital flows. This result may be interpreted as an indication of the ineffectiveness of the reforms that have been adopted by governance and financial institutions in MEDA transitional economies (Habermeier et al., 2011; Eichengreen and Rose, 2014; Forbes et al., 2015; Beirne and Friedrich, 2017; Pasricha, 2020).

Financial development is closely related to the infrastructural development and, in turn, to institutional and governance quality (Dias et al., 2020). In countries governed by unwise governance, where the bribery is high, it is easier to establish collusive relations between economic actors and political elites whose intent is to retain rents (London, 2016). Therefore, where institutional reforms

have been ineffective and where it is a poorly regulated or highly concentrated financial sector, there may be a tendency to create collusive enclaves between the public and private interests, which it is typical of "crony-capitalism".

A possible way to stimulate growth in such transitional economics could be to involve the private sector in the country's democratization process (European Commission, 2021). An effective coexistence between competent financial markets and political stability is a necessary condition to promote development and economic growth in MEDA transitional economies (Scalamonti, 2024).

The development of the financial systems implies improvements in the information flows to firms for their operating decisions, and making them available for household savings (Scalamonti, 2021). As a result, financial markets perform a fundamental allocation function of the resources available to those economic sectors that need them and whose firms can remunerate the loans taken out (Scalamonti, 2025).

In conclusion, inclusive institutions are needed in capital markets to better address complex issues arising from customer segmentation, so that the financial intermediaries can reach the highest savings than form extractive alliances with a narrow elite of customers with high economic potential and strong political power.

### *4.2. Policy implications*

The most immediate implications of this study are that it could be useful to investors and portfolio analysts for investment decisions in the MEDA capital markets. Moreover, it could provide valuable insights for academics and researchers interested in financial aspects of capital markets.

Many researchers have investigated the weak–form efficiency in transitional and emerging economies over the past several years. Following exogenous shocks, financial crisis and "Arab Springs", the interest in MEDA capital markets has increased during the last decade. Insufficient data, inadequate regulations, lack of inspection, rules loose, and broad governance make it difficult to study the informational efficiency in MEDA transitional economies. In general, the transitional and emerging economies are usually characterized by low quality of information disclosure, lack of market transparency, administrative loose, low degree of competition, weak trading volume, and inadequate accounting standards. Sounder institutions, particularly governance climate and more democratic systems, can mitigate the adverse selection caused by social unrest on capital market outcomes (Barrett et al., 2024).

Formal economic activities require good rule of law, efficient regulations, and shared principles for inclusive financial systems (WEF, 2021). In fact, the economic health of a country depends not only on the macroeconomic framework, but also on other factors shaping overall economic activity, such as laws, regulations, and numerus institutional arrangements. In the markets where the regulation is particularly inefficient, levels of informality are higher (World Bank, 2011; Imam and Kpodar, 2016). Therefore, this type of context may be found in the business environments of some MEDA countries with a lag in the reform process. This means that firms in the informal sector grow more slowly, have less access to credit, and employ fewer workers, which remain outside the protections of labor law (Rocha et al., 2011; Al-Ississ, 2012; Wood and Yang, 2016; Fouejieu et al., 2020).

Many efforts should be made to expand and deepen MEDA capital markets to improve liquidity and transparency to enhance institutional and business environment in MEDA transitional economies by supporting regulatory reforms and developing financial systems, which in turn spur investment and economic growth (Corneli, 2021).

Although inefficient markets indicate potential profitable arbitraging trading predicated on market predictability, the consequential investor attraction is not entirely desirable. Inefficient markets also create a congenial framework for insider trading, and they are prone to over-inflated prices and various speculations. Moreover, along periods of high-risk aversion, large portfolio investment reallocations of emerging capital markets have been associated with underperformance of the same, highlighting opportunistic behaviors by investors (Al-Shboul and Alsharari, 2019; Cortes and Sanfilippo, 2021).

### *4.3. Limitations and suggestions*

More in-depth analyses could consider daily, weekly, monthly, and quarterly microdata to have different and longer time series, as well as considering more stock market indices. Data sources to explore include the World Federation of Exchanges, the Financial Corporation Database, the Yahoo Finance Database, the Arab Monetary Fund, or alternative stock exchange databases if data for MEDA countries are available.

Further statistical investigation methods may be used by employing event studies or more sophisticated technical analyses of type non-parametric or linear-parametric. Alternatively, panel data analysis and relative tests may be implemented (e.g.: Clemente et al., 1998; Hadri, 2000; Breitung, 2001; Levin et al., 2002).

In particular, generalized autoregressive conditional heteroskedasticity (GARCH) models making different assumptions about the variance of error terms in the regressions can be effectively implemented using longer time series and with microdata through stock market indices (Engle, 1982; Bollerslev, 1986). The GARCH approach has the advantage of incorporating the volatility clustering characteristics in the estimation process by enabling time variation and temporal dependence of conditional second order moments, namely conditional on the information set at time t-1. As a result, this approach is consistent with excess kurtosis in the unconditional distributions of capital market outcomes. Alternatively, the more efficient conditional autoregressive range (CARR) model could be employed (Chou, 2005).

Additionally, practitioners and academics are aware that most of the markets are not efficient and have developed alternative avenues. Therefore, researchers could consider the novel insight suggested by Lo (2004, 2005), who introduced the adaptive markets hypothesis (AMH) and gave a framework to adapt the EMH with the concept of bounded rationality (Simon, 1957). A crucial implication of the AMH is related to the market efficiency that may vary from time to time because of exogenous market shocks, such as bubbles, crashes, and crises, or endogenous institutional factors.

Under the AMH framework, the EMH and market inefficiencies are consistent alternatives. Indeed, to comply with the varying extent of market efficiency over time, Lo (2004) suggested a new explanation of the EMH originating from evolutionary principles, such as competition, mutation, reproduction, and natural selection. In other words, many of the instances mentioned as contraventions of rationality and that are incompatible with market efficiency, such as loss aversion, overconfidence, and overreaction, are instead compatible with an evolutionary model of individuals reconciling to a changing environment through ordinary trials and errors.

The concepts that constitute the AMH framework are (Lim and Brooks, 2011): (i) Individuals act in their own self-interest; (ii) they make mistakes; (iii) they learn and adapt from their mistakes; (iv) competition drives self-adaptation and innovative behaviors; (v) natural selection shapes market; and (vi) evolutionary dynamics determine markets.

The main issue of this approach is not the presence or absence of efficiency in the markets but the variation of it. Therefore, market efficiency is a characteristic that changes over time, and it is context dependent. This means that the degree of market efficiency is governed by market conditions. For instance, the AMH framework has been studied in some capital markets (Kim et al., 2011; Zhou and Lee, 2013; Lim et al., 2013; Mirzaee–Ghazani and Khalili–Araghi, 2014; Hkiri et al., 2021).

Researchers could also consider the quality of corporate governance among the explanatory variables by utilizing a set of significant indicators and operationalizing the qualitative assessment through an appropriate coding and scoring method (Durnev and Kim, 2005; Brown and Caylor, 2006; Filsaraei, 2024). In fact, better corporate governance tends to provide stronger and higher-quality information to stakeholders, thereby enhancing external operational and financial transparency. In particular, higher-quality corporate governance may foster better alignment between shareholders' and managers' interests, resulting in increased value creation and distribution, as well as reduced agency costs. On the other hand, lower-quality corporate governance may generate higher agency costs.

## Use of AI tools declaration

The author declares they have not used Artificial Intelligence (AI) tools in the creation of this article.

## Acknowledgments

The author is grateful for the advice and suggestions received by anonymous reviewers during the review process.

## Conflict of interest

The author declares no conflict of interest.

## References

Abraham A, Seyyed F, Alsakran S (2002) Testing the random walk behavior and efficiency of the Gulf stock markets. *Fin Rev* 37:469–480. https://doi.org/10.1111/0732-8516.00008

Akgun A, Sahin I (2017) The testing of efficient market hypothesis in Borsa Istanbul. *Ann Const Brancusi Univ Targu Jiu Lett Soc Sci Ser* 2: 35–48.

Alfaro L, Chari A, Greenland A, et al. (2020) Aggregate and firm-level stock returns during pandemics. NBER Work Pap Ser 26950: 1–33. https://doi.org/10.3386/w26950

Al-Ississ M (2012) The access to credit dichotomy: Arab financial markets caught between the pull of the disenfranchised and the push of the entrenched. In: Addressing the 100 Million Youth Challenge: Perspectives on Youth Employment in the Arab World in 2012. Geneva: The World Economic Forum.

Al-Shboul M, Alsharari N (2019) The dynamic behavior of evolving efficiency: Evidence from the UAE stock markets. *Q Rev Econ Finance* 73: 119–135. https://doi.org/10.1016/j.qref.2018.05.007

Ananzeh I (2021) Investigating the efficiency of financial markets: Empirical evidence from MENA countries. *Invest Manag Financ Innov* 18: 250–259. https://doi.org/10.21511/imfi.18(1).2021.21

Angelini P, Guazzarotti G (2010) Information uncertainty and the reaction of stock prices to news. *BoI Work Pap* 465: 1–69.

Anisa S, Fajri-Af M (2024) The impact of Islamic financial literacy on Gen Z's investment decisions in the Islamic capital market. *Islam Cap Mark* 2: 1–10. https://doi.org/10.58968/icm.v2i2.572

Aras G, Yilmaz M (2008) Price-earnings ratio, dividend yield, and market–to–book ratio to predict return on stock market: Evidence from the emerging markets. *J Glob Bus Technol* 4: 18–30.

Asaad Z, Omer B (2024) Random walk tests for the MENA stock returns. *J Enterp Dev* 6: 324–334. https://doi.org/10.20414/jed.v6i2.9819

Assaf A, Charif H (2017) Market efficiency in the MENA equity markets: Evidence from newly developed tests and regime change. *J Rev Glob Econ* 6: 15–32. https://doi.org/10.6000/1929-7092.2017.06.02

Azad A, Azmat S, Fang V, et al. (2014) Unchecked manipulations, price-volume relationship and market efficiency: Evidence from emerging markets. *Res Int Bus Finance* 30: 51–71. https://doi.org/10.1016/j.ribaf.2013.05.003

Bahmani-Oskooee M, Chang T, Chen T, et al. (2016) Revisiting purchasing power parity in Eastern European countries: Quantile unit root tests. *Empir Econ* 52: 463–483. https://doi.org/10.1007/s00181-016-1099-z

Baker S, Bloom N, Davis S, et al. (2020) The unprecedented stock market reaction to COVID-19. *Rev Asset Pricing Stud* 10: 742–758. https://doi.org/10.1093/rapstu/raaa008

Bakri M, Bany-Ariffin A, Matemilola B, et al. (2020) Moderating role of financial market development on the relationship between stock liquidity and dividend. *Asian Acad Manag J Account Financ* 16: 77–99. https://doi.org/10.21315/aamjaf2020.16.2.4

Barrett P, Bondar M, Chen S, et al. (2024) Pricing protest: the response of financial markets to social unrest. *Rev Finance* 28: 1419–1450. https://doi.org/10.1093/rof/rfae008

Beirne J, Friedrich C (2017) Macroprudential policies, capital flows, and the structure of the banking sector. *J Int Money Finance* 75: 47–68. https://doi.org/10.1016/j.jimonfin.2017.04.004

Belhoula M, Mensi W, Naoui K (2024) Dynamic efficiency in MENA stock markets during Covid-19 outbreak and vaccines. *Int J Emerg Mark*. https://doi.org/10.1108/ijoem-10-2022-1566

Bhattacharya S, Bhattacharya M, Basu S (2019) Stock market and its liquidity: Evidence from ARDL bound testing approach in the Indian context. *Cogent Econ Financ* 7: 1–12. https://doi.org/10.1080/23322039.2019.1586297

Bollerslev T (1986) Generalized autoregressive conditional heteroskedasticity. *J Econom* 31: 307–327. https://doi.org/10.1016/0304-4076(86)90063-1

Borges M (2010) Efficient market hypothesis in European stock markets. *Eur J Financ* 16: 711–726. https://doi.org/10.1080/1351847x.2010.495477

Breitung J (2001) The local power of some unit root tests for panel data, In: Baltagi B, Fomby T, Carter-Hill R (Eds.), *Nonstationary Panels, Panel Cointegration, and Dynamic Panels*, Leeds: Emerald, 161–177. https://doi.org/10.1016/S0731-9053(00)15006-6

Brown L, Caylor M (2006) Corporate governance and firm valuation. *J Account Public Policy* 25: 409–434. https://doi.org/10.1016/j.jaccpubpol.2006.05.005

Brown S (2020) The efficient market hypothesis, the financial analysts journal, and the professional status of investment management. *Fin Anal J* 76: 5–14. https://doi.org/10.1080/0015198X.2020.1734375

Campbell J, Lo A, MacKinlay A (Eds.) (1997) *The Econometrics of Financial Markets*, Princeton: Princeton Univ Press. https://doi.org/10.1515/9781400830213

Caporale G, Gil-Alana L, Poza C (2020) High and low prices and the range in the European stock markets: A long-memory approach. *Res Int Bus Financ* 52: 101126. https://doi.org/10.1016/j.ribaf.2019.101126

Chambino M, Horta N, Dias R (2023) Market predictability and mean reversion in MENA markets: An empirical study of equity market efficiency. *EMAN-Int Sci Conf* 7: 19–33. https://doi.org/10.31410/eman.s.p.2023.19

Charfeddine L, Khediri K (2016) Time varying market efficiency of the GCC stock markets. *Physica A* 444: 487–504. https://doi.org/10.1016/j.physa.2015.09.063

Chikwira C, Mohammed J (2023) The impact of the stock market on liquidity and economic growth: Evidence of a volatile market. *Economies* 11: 1–19. https://doi.org/10.3390/economies11060155

Chou R (2005) Forecasting financial volatilities with extreme values: The conditional autoregressive range (CARR) model. *J Money Credit Bank* 37: 561–582. https://doi.org/10.1353/mcb.2005.0027

Clemente J, Montañés A, Reyes M (1998) Testing for a unit root in variables with a double change in the mean. *Econ Lett* 59: 175–182. https://doi.org/10.1016/S0165-1765(98)00052-4

Copeland T, Weston J, Shastri K (2005) *Financial Theory and Corporate Policy*, 4th ed. London: Wesley.

Corneli F (2021) Financial integration without financial development. *Atl Econ J* 49: 201–220. https://doi.org/10.1007/s11293-021-09709-2

Cortes F, Sanfilippo L (2021) Multi-sector bond funds in emerging markets: Easy come, easy go. *Glob Financ Stab Notes* 2021: 1–9. https://doi.org/10.5089/9781616357689.065

Cortina J, Ismail S, Schmukler S (2018) Firm financing and growth in the Arab region. *Econ Syst* 42: 361–383. https://doi.org/10.1016/j.ecosys.2017.09.002

Dal Bianco S, Amini C, Signorelli M (2017) The impact of the global financial crisis and the role of external and internal factors in emerging economies. *Emerg Mark Financ Trade* 53: 229–249. https://doi.org/10.1080/1540496X.2016.1216840

Davidson J (2018) *An Introduction to Econometric Theory.* Berlin: Wiley. https://doi.org/10.1002/9781119484905

Degutis A, Novickytė L (2014) The efficient market hypothesis: A critical review of literature and methodology. *Ekonomika* 93: 7–23. https://doi.org/10.15388/ekon.2014.2.3549

Dias R, Teixeira N, Machova V, et al. (2020) Random walks and market efficiency tests: Evidence on US, Chinese and European capital markets within the context of the global COVID-19 pandemic. *Oeconomia Copernicana* 11: 585–608. https://doi.org/10.24136/oc.2020.024

Dickey D, Fuller W (1979) Distribution of the estimators for autoregressive time series with a unit root. *J Am Stat Assoc* 74: 427–431. https://doi.org/10.1080/01621459.1979.10482531

Ding W, Levine R, Lin C, et al. (2021) Corporate immunity to the COVID-19 pandemic. *J Financ Econ* 141: 802–830. https://doi.org/10.1016/j.jfineco.2021.03.005

Durnev A, Kim E (2005) To steal or not to steal: Firm attributes, legal environment, and valuation. *J Financ* 60: 1461–1493. https://doi.org/10.1111/j.1540-6261.2005.00767.x

Eichengreen B, Rose A (2014) Capital controls in the 21st century. *J Int Money Financ* 48: 1–16. https://doi.org/10.1016/j.jimonfin.2014.08.001

Elangovan R, Irudayasamy F, Parayitam S (2022) Testing the market efficiency in Indian stock market: Evidence from Bombay Stock Exchange broad market indices. *J Econ Finance Adm Sci* 27: 313–327. https://doi.org/10.1108/JEFAS-04-2021-0040

El-Diftar D (2024) The applicability of the efficient market hypothesis in emerging markets. *Arab J Adm* 44: 367–376. https://doi.org/10.21608/aja.2021.89040.1130

El-Khamlichi A, Sarkar K, Arouri M, et al. (2014) Are Islamic equity indices more efficient than their conventional counterparts? Evidence from major global index families. *J Appl Bus Res* 30: 1137–1150. https://doi.org/10.19030/jabr.v30i4.8660

Engle R (1982) Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica* 50: 987–1007. https://doi.org/10.2307/1912773

European Commission (2021) Ex-post evaluation of the impact of trade chapters of the Euro-Mediterranean Association Agreements with six partners: Algeria, Egypt, Jordan, Lebanon, Morocco and Tunisia. Brussels: EU.

Fama E (1991) Efficient capital markets: II. *J Financ* 46: 1575–1617. https://doi.org/10.1111/j.1540-6261.1991.tb04636.x

Fama E, French K (1988) Dividend yields and expected stock returns. *J Financ Econ* 22: 3–25. https://doi.org/10.1016/0304-405X(88)90020-7

Filsaraei M (2024) Stock liquidity, corporate governance and dividend payout: Evidence from Tehran Stock Exchange. E*con Manag Inf* 3: 1–12. https://doi.org/10.62836/emi.v3i1.107

Forbes K, Fratzscher M, Straub R (2015) Capital-flow management measures: What are they good for? *J Int Econ* 96: S76–S97. https://doi.org/10.1016/j.jinteco.2014.11.004

Fouejieu A, Ndoye A, Sydorenko T (2020) Unlocking access to finance for SMEs. *IMF Work Pap* 20: 1–32. https://doi.org/10.5089/9781513536156.001

Guerrieri V, Lorenzoni G, Straub L, et al. (2022) Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages? *Am Econ Rev* 112: 1437–1474. https://doi.org/10.1257/aer.20201063

Habermeier K, Kokenyne A, Baba C (2011) The effectiveness of capital controls and prudential policies in managing large inflows. *Staff Discuss Notes* 11: 1–35. https://doi.org/10.5089/9781463902896.006

Hadri K (2000) Testing for stationarity in heterogeneous panel data. *Econom J* 3: 148–161. https://doi.org/10.1111/1368-423x.00043

Hamid K, Suleman M, Ali-Shah S, et al. (2010) Testing the weak-form of efficient market hypothesis: Empirical evidence from Asia-Pacific markets. *Int Res J Financ Econ* 58: 121–132.

Hkiri B, Béjaoui A, Gharib C, et al. (2021) Revisiting efficiency in MENA stock markets during political shocks: Evidence from a multi-step approach. *Heliyon* 7: e08028. https://doi.org/10.1016/j.heliyon.2021.e08028

Imam P, Kpodar K (2016) Islamic banking: Good for growth? *Econ Model* 59: 387–401. https://doi.org/10.1016/j.econmod.2016.08.004

Kamal M (2014) Studying the validity of the efficient market hypothesis (EMH) in the Egyptian Exchange (EGX) after the 25th of January Revolution. *MPRA Work Pap Ser* 54708: 1–15.

Kelikume I, Olaniyib E, Iyohab F (2020) Efficient market hypothesis in the presence of market imperfections: Evidence from selected stock markets in Africa. *Int J Manag Econ Soc Sci* 9. https://doi.org/10.32327/ijmess/9.1.2020.3

Kendall M, Hill A (1953) The analysis of economic time-series-Part I: Prices. *J R Stat Soc* 116: 11. https://doi.org/10.2307/2980947

Kim J, Shamsuddin A, Lim K (2011) Stock return predictability and the adaptive markets hypothesis: Evidence from century-long U.S. data. *J Empir Finance* 18: 868–879. https://doi.org/10.1016/j.jempfin.2011.08.002

Kolmogorov A (1933) Sulla determinazione empirica di una legge di distribuzione. G*iorn Ist Ital Attuari* 4: 83–91.

Kwiatkowski D, Phillips P, Schmidt P, et al. (1992) Testing the null hypothesis of stationarity against the alternative of a unit root. *J Econom* 54: 159–178. https://doi.org/10.1016/0304-4076(92)90104-y

Lagoarde-Segot T, Lucey B (2008) Efficiency in emerging markets: Evidence from the MENA region. *J Int Financ Mark Inst Money* 18: 94–105. https://doi.org/10.1016/j.intfin.2006.06.003

Lahmiri S (2013) Do MENA stock market returns follow a random walk process? *Int J Ind Eng Comput* 4: 165–172. https://doi.org/10.5267/j.ijiec.2012.11.005

Latham M (1985) Defining capital market efficiency. IBER-Finance Working Papers No. 150, Berkeley, CA: University of California.

Lekhal M, El-Oubani A (2020) Does the Adaptive Market Hypothesis explain the evolution of emerging markets efficiency? Evidence from the Moroccan financial market. *Heliyon* 6: e04429. https://doi.org/10.1016/j.heliyon.2020.e04429

Levin A, Lin F, Chu C (2002) Unit root tests in panel data: asymptotic and finite-sample properties. *J Econom* 108: 1–24. https://doi.org/10.1016/s0304-4076(01)00098-7

Lim K, Brooks R (2011) The evolution of stock market efficiency over time: a survey of the empirical literature. *J Econ Surv* 25: 69–108. https://doi.org/10.1111/j.1467-6419.2009.00611.x

Lim K, Luo W, Kim J (2013) Are US stock index returns predictable? Evidence from automatic autocorrelation-based tests. *Appl Econ* 45: 953–962. https://doi.org/10.1080/00036846.2011.613782

Ljung G, Box G (1978) On a measure of lack of fit in time series models. *Biometrika* 65: 297–303. https://doi.org/10.1093/biomet/65.2.297

Lo A (1991) Long-term memory in stock market prices. *Econometrica* 59: 1279. https://doi.org/10.2307/2938368

Lo A (2004) The Adaptive Markets Hypothesis. *J. Portf Manag* 30: 15–29. https://doi.org/10.3905/jpm.2004.442611

Lo A (2005) Reconciling efficient markets with behavioral finance: the adaptive markets hypothesis. *J Invest Consult* 7: 21–44.

Lo A, MacKinlay A (1988) Stock market prices do not follow random walks: evidence from a simple specification test. *Rev Financ Stud* 1: 41–66. https://doi.org/10.1093/rfs/1.1.41

London T (2016) *The base of the pyramid promise: building businesses with impact and scale.* Stanford, CA: Stanford University Press. https://doi.org/10.1515/9780804797337

Mäkinen T (2014) Informed trading and stock market efficiency. BoI-Working Papers No. 992, 1–37.

Malafeyev O, Awasthi A, Kambekar SK, et al. (2019) Random walks and market efficiency in Chinese and Indian equity markets. *Stat Optim Inf Comput* 7. https://doi.org/10.19139/soic.v7i1.499

Malkiel B, Fama E (1970) Efficient capital markets: a review of theory and empirical work. *J Financ* 25: 383–417. https://doi.org/10.1111/j.1540-6261.1970.tb00518.x

Mehla S, Goyal SK (2012) Empirical evidence on weak form of efficiency in Indian stock market. *Asia-Pac J Manag Res Innov* 8: 59–68. https://doi.org/10.1177/2319510x1200800107

Miloş L, Haţiegan C, Miloş M, et al. (2020) Multifractal detrended fluctuation analysis (MF-DFA) of stock market indexes. Empirical evidence from seven Central and Eastern European markets. *Sustainability* 12: 535–549. https://doi.org/10.3390/su12020535

Mirzaee-Ghazani M, Khalili-Araghi M (2014) Evaluation of the adaptive market hypothesis as an evolutionary perspective on market efficiency: Evidence from the Tehran stock exchange. *Res Int Bus Financ* 32: 50–59. https://doi.org/10.1016/j.ribaf.2014.03.002

Mohti W, Dionísio A, Ferreira P, et al. (2018) Frontier markets' efficiency: mutual information and detrended fluctuation analyses. *J Econ Interact Coord* 14: 551–572. https://doi.org/10.1007/s11403-018-0224-9

Moro A, Schiavone A (2022) The role of non-bank financial institutions in the intermediation of capital flows to emerging markets. BoI-Working Papers No. 1367, 1–60.

Mynhardt H, Plastun A, Makarenko I (2014) Behavior of financial markets efficiency during the financial market crisis: 2007–2009. *Corp Ownersh Control* 11: 531–546. https://doi.org/10.22495/cocv11i2c5p4

Naik P, Reddy Y (2021) Stock market liquidity: A literature review. *SAGE Open* 11: 1–15. https://doi.org/10.1177/2158244020985529

Naseer M, Bin Tariq D (2015) The efficient market hypothesis: a critical review of the literature. *IUP J Financ Risk Manag* 12: 48–63.

Ngene G, Tah K, Darrat A (2016) The random-walk hypothesis revisited: new evidence on multiple structural breaks in emerging markets. *Macroecon Financ Emerg Mark Econ* 10: 88–106. https://doi.org/10.1080/17520843.2016.1210189

Nisar S, Hanif M (2012) Testing market efficiency: empirical evidence from developed markets of Asia Pacific. *World Appl Sci J* 17: 414–427.

Öztürk-Savaş H, Çetin M (2025) International stock market dependencies: the causality approach. *Trends Bus Econ* 39: 208–219. https://doi.org/10.16951/trendbusecon.1475528

Pasricha G (2020) Estimated policy rules for capital controls. *IMF Work Pap* 20: 1–50. https://doi.org/10.5089/9781513546100.001

Peterkort R, Nielsen J (2005) Is the book-to-market ratio a measure of risk? *J Financ Res* 28: 487–502. https://doi.org/10.1111/j.1475-6803.2005.00135.x

Quandt R (1960) Tests of the hypothesis that a linear regression system obeys two separate regimes. *J Am Stat Assoc* 55: 324. https://doi.org/10.2307/2281745

Ramelli S, Wagner A (2020) Feverish stock price reactions to Covid-19. Rev. *Corp Financ Stud* 9: 622–655. https://doi.org/10.1093/rcfs/cfaa012

Razali N, Wah Y (2011) Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. *J Stat Model Anal* 2: 21–33.

Rejichi I, Aloui C (2012) Hurst exponent behavior and assessment of the MENA stock markets efficiency. *Res Int Bus Financ* 26: 353–370. https://doi.org/10.1016/j.ribaf.2012.01.005

Riyath M, Jahfer A (2018) Book to market ratio and expected stock return: An empirical study on the Colombo stock market. *J Manag* 12: 81–89. https://doi.org/10.4038/jm.v12i1.7589

Rocha R, Farazi S, Khouri R, et al. (2011) The status of bank lending to SMEs in the Middle East and North Africa region: results of a joint survey of the Union of Arab Bank and the World Bank. Policy Res. Work. Pap. Ser. No. 5607, 1–61. https://doi.org/10.1596/1813-9450-5607

Rossi M (2015) The efficient market hypothesis and calendar anomalies: a literature review. *Int J Manag Financ Account* 7: 285. https://doi.org/10.1504/ijmfa.2015.074905

Rubinstein M (1975) Securities market efficiency in an Arrow-Debreu economy. *Am Econ Rev* 65: 812–824.

Saad D, Faouzi B (2024) Efficiency trends and challenges in MENA financial markets. *Int J Strateg Manag Econ Stud* 3: 1199–1217.

Saeedi A, Miraskari S, Ara M (2014) The Investigation of the Efficient Market Hypothesis: Evidence from an Emerging Market. *Taylor's Bus Rev* 4: 121–134. https://doi.org/10.7603/s40932-014-0001-0

Satapathy A (2025) Test of Random Walk Hypothesis in Indian Stock Market, and Verify Any Relationship Between Market Efficiency and Liquidity. *Glob Bus Rev.* https://doi.org/10.1177/09721509251344434

Scalamonti F (2021) The transition of the southern economies of Mediterranean Sea: the macroeconomic framework and the determinants of foreign investments. *Ind Rev Ind Econ Policy* 42: 533–578. https://doi.org/10.1430/98711

Scalamonti F (2024) A quantitative and qualitative macroeconomic and sociopolitical outlook of the MEDA transitional economies: development-paths, governance climate, and sociocultural factors. *Natl Account Rev* 6: 407–448. https://doi.org/10.3934/NAR.2024019

Scalamonti F (2025) The determinants of SMEs' internationalisation across MEDA transitional economies. SSRN Work. Pap. Ser.: 1–23. https://doi.org/10.2139/ssrn.5084116

Sensoy A (2013) Generalized Hurst exponent approach to efficiency in MENA markets. *Physica A* 392: 5019–5026. https://doi.org/10.1016/j.physa.2013.06.041

Shaik M, Maheswaran S (2017) Market efficiency of ASEAN stock markets. *Asian Econ Financ Rev* 7: 109–122. https://doi.org/10.18488/journal.aefr/2017.7.2/102.2.109.122

Shapiro S, Wilk M (1965) An analysis of variance test for normality (complete samples). *Biometrika* 52: 591–611. https://doi.org/10.1093/biomet/52.3-4.591

Simon H (1957) *Models of man: social and rational.* New York, NY: Wiley Press.

Smirnov N (1948) Table for estimating the goodness of fit of empirical distributions. *Ann Math Stat* 19: 279–281. https://doi.org/10.1214/aoms/1177730256

Smith G (2008) Liquidity and the informational efficiency of African stock markets. *S Afr J Econ* 76: 161–175. https://doi.org/10.1111/j.1813-6982.2008.00171.x

Ţiţan A (2015) The efficient market hypothesis: review of specialized literature and empirical research. *Procedia Econ Financ* 32: 442–449. https://doi.org/10.1016/s2212-5671(15)01416-1

Uroqova B (2024) Islamic finance as a tool to improve financial inclusion in Uzbekistan: implications for reducing poverty and income inequality. SSRN Work. Pap. Ser.: 1–20. http://dx.doi.org/10.2139/ssrn.4993193

Visaggio M (2024) *The great economic phases between black swans and gray swans.* Milan, IT: McGraw-Hill.

WEF (2020) The post-Covid-19 financial system. WEF White Pap, 1–34.

WEF (2021) Shared principles for an inclusive financial system. WEF White Pap, 1–30.

Wood C, Yang J (2016) MENA export performance and specialization: the role of financial sector development and governance. Policy Res. Work. Pap. Ser. No. 7616, 1–32. https://doi.org/10.1596/1813-9450-7616

World Bank (2011) MENA development report: financial access and stability: a road map for the Middle East and North Africa. Washington, DC: The World Bank Group.

Worthington A, Higgs H (2004) Random walks and market efficiency in European equity markets. *Glob J Financ Econ* 1: 59–78.

Yildirim H (2017) Behavioral finance efficient market hypothesis. *Int J Acad Value Stud* 3: 151–158. https://doi.org/10.23929/javs.247

Ying Q, Yousaf T, Ain Q, et al. (2019) Stock investment and excess returns: A critical review in the light of the efficient market hypothesis. *J Risk Financ Manag* 12: 1–22. https://doi.org/10.3390/jrfm12020097

Zhou J, Lee M (2013) Adaptive market hypothesis: evidence from the REIT market. *Appl Financ Econ* 23: 1649–1662. https://doi.org/10.1080/09603107.2013.844326


AIMS Press