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ASSESSING INFORMATION EFFICIENCY IN THE IRAQI STOCK MARKET

This study examines the ISX in weak-form market efficiency from August 2014 to August 2024 by testing the random walk hypothesis using daily data for the 57 individual constituents of the ISX60. The paper applies a number of statistical techniques, including unit root tests (Augmented Dickey-Fuller and Phillips-Perron), autocorrelation (Ljung-Box Q-statistic), and variance ratio and runs tests. We report evidence of statistically significant bias against the random walk hypothesis. While all stocks demonstrate stationarity, 70–79% of the stocks are stated to have violated the hypothesis of the random walk on several tests at the 5% significance level. The index also exhibits particularly strong evidence of market inefficiency, with variance ratio metrics falling within the 0.50–0.75 range, demonstrating evidence of market inefficiency and significant mean reversion. This information suggests that empirical data from prior prices can indeed predict possible returns, thus demonstrating a weakness in the weak-form efficiency of the market. In combination with evidence from prior research on border markets, attributed to thin trading, limited market liquidity, information asymmetry, herding behavior, and a lack of strong market infrastructure, this research helps to identify the potential for technical trading and suggests that transaction costs may hinder market inefficiency. The research also identifies several areas of focus for market infrastructure, such as enhanced liquidity, improved frameworks for disclosures, and a greater role for institutional

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ОЦІНЮВАННЯ ІНФОРМАЦІЙНОЇ ЕФЕКТИВНОСТІ НА ІРАКСЬКОМУ ФОНДОВОМУ РИНКУ

Дослідження оцінює інформаційну ефективність ринку ISX за період з серпня 2014 р. по серпень 2024 р. шляхом перевірки гіпотези про випадковий характер зміни цін з використанням щоденних даних для 57 окремих складових ISX60. Застосовано низку статистичних методів, зокрема тести на одиничні корені (розширений тест Дікі-Фуллера та П. Гілліпса-Перрона), автокореляцію (Q-статистика Люнга-Бокса) та коефіцієнт дисперсії, а також проводиться тестування. Виявлено статистично значущі докази відхилення від гіпотези стохастичної динаміки цін. Хоча всі акції демонструють стаціонарність, 70–79% акцій, як стверджується, порушили гіпотезу стохастичної динаміки цін за кількома тестами на рівні значущості 5%. Індекс демонструє особливо вагомі докази неефективності ринку, причому показники коефіцієнта дисперсії перебувають у діапазоні 0,50–0,75, що свідчить про відхилення від гіпотези ефективності та наявність ефекту повернення до середнього значення. Це вказує на те, що емпіричні дані з попередніх прайсів дійсно можуть передбачати можливу прибутковість, демонструючи таким чином слабкість ефективності ринку. У поєднанні з даними попередніх досліджень прикордонних ринків, які пояснюються слабкою торгівлею, обмеженою ліквідністю ринку, інформаційною асиметрією, стадною поведінкою та недостатньо розвиненою ринковою інфраструктурою, дослідження допомагає визначити потенціал для технічної торгівлі та приводить до припущення, що транзакційні витрати можуть стримувати прояви ринкової неефективності. Дослідження визначає кілька напрямів розвитку ринкової інфраструктури,

investors to foster market stability. The proof aids in the comprehension of the efficiency dynamics of frontier markets and the Iraqi equity market's impact on economic growth.

Keywords: random walk hypothesis, market efficiency, Iraqi Stock Exchange, frontier markets, variance ratio test, emerging markets.

зокрема підвищення ліквідності, вдосконалення систем розкриття інформації та посилення ролі інституційних інвесторів у сприянні стабільності ринку. Отримані результати дають змогу краще зрозуміти динаміку ефективності прикордонних ринків та вплив іракського фондового ринку на економічне зростання.

Ключові слова: гіпотеза випадкового блукання, ефективність ринку, іракська фондова біржа, прикордонні ринки, тест на коефіцієнт дисперсії, ринки, що розвиваються.

JEL Classification: G14, G15, C58, C12, O16.

Introduction

In the domain of finance, Fama (1970) developed the efficient market hypothesis, which posits that all available information is incorporated into asset prices. For the weak-form market efficiency hypothesis, which is the focus of this study, the current price captures all available information on previous price series, meaning that the price can be analyzed to make abnormal returns. This is tested through the random walk hypothesis (RWH), which presumes that price changes are independent and come from the same distribution. When stock returns are analyzed to determine whether they follow a random walk, we arrive at weak-form market efficiency, a paradigm shift in the understanding of investment, regulation, and financial theory.

Theoretically, there has been a lot of work done on the efficiency of markets in developed economies; on the other hand, frontier markets are still relatively unexplored despite their increasing significance in worldwide capital investment. Frontier markets are smaller in size, have less liquidity and lower institutional participation, and have unformed regulatory frameworks. These characteristics present unique obstacles for efficient price discovery. These markets are very useful for testing different combinations of variables, such as institutional and market microstructure, resulting in various levels of efficiency. In particular, the Middle East and North Africa (MENA) regions have varying degrees of efficiency, with some markets exhibiting developmental characteristics and others remaining significantly inefficient.

The Iraqi Stock Exchange (ISX) began operations in 2004. The exchange is one of the smallest and underdeveloped stock markets in the Middle East, with a market capitalization of less than 1% of the Arab Financial Markets. The daily trades of ISX show typical characteristics of frontier markets; these include limited liquidity, more retail investors than institutional, greater trading volatility, limited foreign investors, and political and economic risk. The ISX is vital in distributing economic resources related to the reconstruction of Iraq. The market infrastructure has been adapted to facilitate electronic trading, introduced in 2009, and the ISX60 index. However, the efficiency of the market continues to be in question.

The most recent research publications indicate that analyses of studies concerning the Iraqi stock exchange (ISX) have temporal limitations (2004–2020) and certain limitations (Kaehler et al., 2014; Asaad et al., 2015;

Asaad & Al-Delawi, 2022; Saleem et al., 2023). To date, no study has conducted a multi-method, longitudinal analysis that spans a decade and examines the universe of ISX 60 constituents, including the COVID-19 crisis. The literature on frontier markets, unlike the ISX, shows chronic weak-form inefficiencies due to insufficient trading, asymmetric information, and poorly developed structures (Lee & Choi, 2023; Said et al., 2024).

The aim of the article is to assess Weak Form Market Efficiency on the Iraqi Stock Exchange by analyzing the Random Walk Hypothesis. The study employs a robust dataset consisting of daily records from August 2014 to August 2024, spanning 10 years and covering 57 constituent stocks of the ISX60 index and the ISX market index.

The central hypothesis of this research is that daily stock returns on the Iraqi Stock Exchange follow a random walk – that is, successive price changes are independent and identically distributed – consistent with weak-form market efficiency. This hypothesis is tested, and its validity is assessed through the convergent application of multiple statistical tests.

The approach for this investigation begins with the logarithmic daily returns and attempts sequentially the following: (1) unit root tests (Augmented Dickey-Fuller and Phillips-Perron) to determine if the data exhibits stationarity; (2) for some levels of serial correlation, we do an autocorrelation (Ljung-Box Q-statistic) at lag 5, 10, and 15; (3) Variance ratio tests (Lo & MacKinlay, 1988) for the holding periods of k = 2, 4, 8, and 16 days to determine any predictability of returns; and (4) to determine the presence of non-parametric runs (Wald & Wolfowitz, 1940) to determine if there is randomness with no distributional assumptions. Official records of daily closing prices from the Iraqi Stock Exchange are the source of data for this study. The primary limitation of this research is the fact that non-linear dependencies and transaction costs are modelled implicitly.

Though research regarding the Iraqi market is quite sparse, it shows the same market inefficiencies. A majority of the studies, however, focus on shorter time horizons and/or use simplistic approaches. This study strengthens the literature by presenting updated and detailed evidence of weak-form market inefficiencies in the Iraqi equity market. Concretely, we examine the ISX60 Index's 57 constituent stocks, and we assess and analyze the market's 10-year daily data from the time period of August 2014 through August 2024, which is characterized by distinct and diverse sets of economic and political events, inclusive of the COVID-19 pandemic, from which we draw the greatest amount of time-domain variance. To analyze the Iraqi stock returns, which reflect the independence and the unpredictability, we use the Random Walk hypothesis, through the use of rigorous statistical unit root tests (Augmented Dickey-Fuller and Phillips-Perron), the autocorrelation tests (Ljung-Box Q-statistic), the variance ratio tests, and the non-parametric runs tests.

There are three contributions to the research. First, it delivers the latest and most detailed analysis on the current ISX60 constituents by providing an

extension on previously done work, including updated data until the year 2024. Second, the application of various complementary methodologies (both parametric and non-parametric; time and frequency domain) offers supporting findings on market efficiency, reinforcing the conclusions beyond a single-test approach. Third, by assessing efficiency on the individual stock and the overall index levels, the analysis ascertains whether diversification impacts efficiency characteristics, a query that has clear implications for the construction of portfolios in frontier markets.

The remainder of the paper is organized as follows: section 1 discusses the market efficiency theories and reviews the relevant empirical research available for the MENA region and for Iraq in particular as an atypical representative of the emerging and frontier markets. In Section 2, the author outlines the data and the techniques employed to evaluate the random walk hypothesis. In Section 3, the author presents the results of the random walk hypothesis, which are exemplified by descriptive statistics, unit root tests, autocorrelation tests, variance ratio tests, and runs tests. In Section 4, the author outlines the results of the random walk hypothesis, provides an analysis of the results, compares the findings to those from other markets, and examines the results from the perspective of practitioners and policymakers.

1. Literature review

1.1. Theoretical framework

Market efficiency as a concept and area of inquiry begins with the Efficient Market Hypothesis (EMH). Its origin can be traced back to the work of Fama (1970). In Fama's definition of an efficient market, he states that an efficient market is one where "security prices fully reflect all available information". Fama introduced this formulation of the market efficiency criterion together with the now-common classifications of weak-form, semi-strong, and strong-form market efficiencies. Under the criteria of weak-form efficiency, prices are said to fully reflect all information contained in past prices, and thus, the practice of technical analysis will never succeed in generating positive abnormal returns. The Random Walk Hypothesis (RWH) is the articulation of this concept in which it is alleged that successive price changes will be a series of independent and identically distributed random variables.

The source of the mathematics behind the random walk for the first time was Samuelson (1965), who showed that in an informal efficient market and rational expectations, anticipated prices will have to vary randomly. Subsequently (Fama, 1991), accepted that there are some predictable features of returns, but he brought in the "joint-hypothesis problem": market efficiency cannot be tested without an asset pricing model. This theoretical warning is particularly pertinent for an efficiency test, since the rejection of a random walk could be an indication of model misspecification or real inefficiency.

1.2. Methodological developments

Of the many possible ways to test the random walk hypothesis, the most popular is most likely the variance-ratio test, as proposed by Lo and MacKinlay (1988). Lo and MacKinlay, in constructing their test, state that, in the case of RWH, the variance of k-period returns must equal k times the variance of 1-period returns. Subsequent improvements include the multiple variance ratio test by Chow and Denning (1993), which aims to eliminate the bias of sequential testing, and Wright (2000), a non-parametric test that employs ranks and signs to obtain the exact null distribution.

Another critical aspect of the methodology is the use of unit root tests. The ADF test (Dickey & Fuller, 1979) determines whether a given time series has a unit root, with a random walk in prices/returns being the stationarity condition. The non-parametric, serial correlation robust corrections of Phillips and Perron (1988) and the reverse null hypothesis of stationarity proposed by Kwiatkowski et al. (1992) – the KPSS test – were applied to the series. The Ljung-Box Q-statistic (Ljung & Box, 1978) offers direct proof of serial correlation by analyzing whether the past returns can predict the future returns.

1.3. Evidence from emerging and frontier markets

Numerous studies confirm that less developed markets show less efficiency than developed ones. (Bekaert & Harvey, 2003) provided one of the first and most complete studies of the characteristics of emerging markets, where they highlighted greater volatility, lower liquidity, and higher segmentation. More recently, Lee and Choi (2023) analyzed 60 markets using multifractal detrended fluctuation analysis, and they showed that all frontier markets possess Hurst exponents that are significantly greater than 0.5, indicating persistent and non-random behavior in the markets.

Specific emerging markets have predominant studies that show the rejection of the random walk hypothesis. (Nazlioglu et al., 2024) say that sharp structural breaks seem to reject the inefficiency, and these breaks test gradual shifts, so the authors provide more support for the EMH and state that there is a methodological point to consider. For Asian markets, for example, Shamshir et al. (2018) document strong serial dependence in Pakistan, as Elangovan et al. (2022) also find India’s inefficiency in the Bombay Stock Exchange. On the other hand, Jr. & Camba (2020) find the Philippine market efficient using the Chow-Denning test, and provide an example. (de Villiers et al., 2020) is the one study for inefficient African Frontier Markets. Using a non-linear ESTAR model on the eight African Markets, de Villiers finds mean reversion and an asymmetric adjustment that does not fit the random walk hypothesis.

1.4. MENA region evidence

The majority of research pertaining to the MENA markets shows MENA markets as inefficient in the weak-form. Multiple variance ratio tests by Al-Ajmi and Kim (2012) applied to all GCC markets show RWH to be rejected for Saudi Arabia, UAE, Kuwait, Oman, Qatar, and Bahrain, even after accounting for thin trading. Jamaani and Roca (2015) built on this analysis and documented inefficiency in the GCC markets, both in isolation and in unison. More specifically for Saudi Arabia, Al-Faryan and Dockery (2021) contend that although the RWH was rejected in total for the Saudi market over the period of 1994–2016, efficiency did seem to improve post the 2007 corporate governance reforms, thus supporting the notion of increasing efficiency.

Markets in Turkey are a notable exception (Gozbasi et al., 2014), who conducted non-linear unit root tests on Borsa Istanbul and found that although there is non-linear behavior, the market follows a random walk, which is in line with weak-form efficiency. Evidence for the remaining MENA markets is distinctly negative. Obeidat et al. (2021) do not support RWH for the Amman Stock Exchange in Jordan, whereas Ananzeh (2021) identified inefficiency in Jordan, Egypt, Saudi Arabia, the UAE, Bahrain, and Oman, and concluded that the absence of regulatory reform is a cause. Al-Khazali et al. (2007) provide a significant methodological caveat, as they showed that thin trading adjustments of a particular kind can change outcomes, and they found efficiency in eight MENA markets after bias correction.

1.5. Iraqi stock exchange research

Although the Iraqi Stock Exchange is relatively young (established in 2004; electronic trading 2009) and research on the Exchange is still at a primary level, studies have been describing the market as inefficient. (Kaehler et al., 2014) was the first to study the ISX, and it was based on a 2004–2013 data time frame. The study utilized variance ratio tests and GARCH modeling to analyze the market, and subsequently was one of the first to reject RWH. He also mentioned the lack of liquidity as a dominant factor. The study noted ISX movement as being dominated by changes in the market exchange rate, security situation, and electricity, and not by changes in fundamental information.

Subsequent studies confirm inefficiency. Asaad et al. (2015) analyzed data from every day of the period 2010–2014 using several techniques; all tests led them to reject the RWH. All of the previous studies on RWH cite Asaad et al. (2015), and this individual bank stocks survey covers the years 2004–2014 and concludes that every single one of the bank securities is inefficient; this was the first study of a single sector for the ISX. Asaad and Al-Delawi (2022) cite RWH as rejected for 2019-2020 industrial companies

for the most recent studies, and Saleem et al. (2023) cite inefficiency for all years to 2023 for ISX and the Arab Federation of Exchanges index.

Studies conducted during the COVID-19 pandemic corroborated these findings. Asaad (2021) applied the ARDL methodology to the ISX60 index and confirmed its inefficiency, experiencing significant effects from oil prices and no significant effects from gold and the exchange rate, consistent with the local, insulated market. Marane (2022) synthesized the literature on the Iraq stock exchange (ISX), noting that its market capitalization accounts for less than 1% of the total market capitalization of the Arab financial markets and describing the persistent low liquidity, high political risk, and illiquid information/research dissemination environment.

1.6. Explanations for market inefficiency

From the literature, there are many mechanisms that describe the mismatches in the efficiency of frontier markets. Due to a lack of volume or liquidity constraints, dead/stale prices create a false autocorrelation; however, Loc et al. (2010) showed that inefficiencies in the Vietnamese market continued to exist despite thin trading corrections. Said et al. (2024) show that, across five emerging markets, the most important factors influencing the time-varying efficiencies are liquidity, volatility, and transaction costs.

Institutional elements are crucial. Weak property rights inhibit informed arbitrage, resulting in greater price synchronicity in emerging markets (Morck et al., 2000). In South Korea and Taiwan, but not in more developed markets, Chang et al. (2000) attributed significant non-linear herding to poor disclosure. Lesmond (2005) found that transaction costs in emerging markets are, on average, about double compared to developed markets. Saffi and Sigurdsson (2011) showed that obstacles to short-selling inhibit the assimilation of negative information, which worsens price efficiency.

Focusing specifically on Iraq, in one of the previous studies, the author identified the lowest earnings quality in the region and linked poor disclosure to inefficiency in the market (Hassan, 2018). Negative disclosure, low market liquidity, weak institutional structure, limited analyst coverage, high cost of transactions, and information asymmetry all combine to create difficulty in the environment of price discovery, affirming the inefficiency that is documented across all ISX studies.

1.7. Research gap and contribution

While prior research has confirmed the inefficiency of the Iraqi Stock Exchange, this study has several novelties. First, it provides the latest detailed analysis of all constituents of the ISX60 index, having revised the data through 2024, and thus extended previous studies. Second, it uses a wide range of complementary tests, such as the unit root, autocorrelation, variance ratio, and runs tests, thus offering a multi-faceted, though convergent,

evidence across different methods. Third, by examining both individual stocks and the index, it assesses inefficiency across different levels of aggregation. Lastly, the 10-year sample period (2014–2024) incorporates recent trends, including the COVID-19 period, which provides recent evidence on the efficient dynamics of this frontier market.

2. Methodology

2.1. Data description

The current paper utilizes an extensive dataset comprising all 57 constituent stocks of the Iraq Stock Exchange Index (ISX60). The dataset spans 10 years, from 3rd August 2014 to 1st August 2024, resulting in 2.304 daily observations for each stock and the market index. The ISX60 is the main benchmark index for the Iraqi Stock Exchange and includes stocks from all seven economic sectors. These include: 6 in agriculture, 16 in banking, 8 in hotels and tourism, 16 in industry, 4 in insurance, 5 in services, and 2 in investment.

The dataset includes the closing prices for the stocks in the dataset and the closing values of the ISX60 index in Iraqi Dinars (IQD) for each day. This dataset covers a sufficiently long period of time that encompasses numerous cycles of stability and unrest in the political and economic climate of Iraq and includes a range of ISX60 components, so that the dataset is complete, eliminating any potential selection bias and capturing the efficiency features of the Iraqi equity market.

2.2. Variable construction and return calculation

Following standard practice in financial economics literature (Fama, 1965; Harvey, 1995), daily stock returns are computed as continuously compounded (logarithmic) returns. The log return for stock i at time t is calculated as:

$$ri, t \ = \ln \frac{Pi,t}{Pi,t-1} \cdot 100 \qquad (1)$$

where: Pi,t represents the closing price of stock i on day t, and Pi,t-1 denotes the closing price on the previous trading day. Returns are expressed in percentage terms by multiplying by 100.

Theoretical and practical reasons support the selection of log returns in comparison to simple returns. First, log returns are time additive, which allows for the computation of multi-period returns via simple summation of single-period log returns. Second, log returns often meet the normality assumption for parametric statistical tests. Third, logarithmic returns demonstrate symmetry, whereby price increases and subsequent decreases of

the same magnitude yield log returns of the same absolute value and opposite sign (Tsay, 2010). The same methodology for calculating returns was employed for the ISX60 market index to derive market-level returns.

2.3. Statistical tests for the random walk hypothesis

For a thorough examination of the random walk hypothesis, the study applies a set of additional statistical tests. Using several tests is important as the tests possess different powers to detect specific deviations from randomness (Harvey, 1995; Lo & MacKinlay, 1988). A mix of parametric and non-parametric approaches is the best way to evaluate the efficiency of the market.

2.3.1. Descriptive statistics and normality tests

Before hypothesis testing can be conducted, stock returns are examined over the mean, standard deviation, skewness, and other moments to gain a basic understanding of the distributional characteristics. These moments shape the test selection and interpretation, and return behavior understanding. The Jarque-Bera test (Jarque & Bera, 1987) tests the null hypothesis of normality formally:

$$JB = \frac{n}{6} \cdot \left[S^2 + \frac{(K-3)^2}{4}\right] \quad , \quad (2)$$

where: n is the sample size, S is the sample skewness, and *K* is the sample kurtosis. Under the null hypothesis of normality, the *JB* statistic follows a chi-square distribution with two degrees of freedom. Significant departures from normality have implications for the validity of parametric tests and may signal the presence of nonlinear dependencies or extreme events.

2.3.2. Unit root tests

Unit root tests are designed to determine whether a time series is stationary or has a unit root, which directly relates to the random walk hypothesis. One such test is the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979; Said & Dickey, 1984), which tests whether the return series contains a unit root. The ADF test regression with a constant term is represented as follows:

$$\Delta r_t = \alpha + \beta r_{t-1} + \Sigma \gamma_j \Delta r_{t-j} + \varepsilon_t \quad , \quad (3)$$

where: Δ denotes the first difference operator, *rt* is the return at time *t*, α is a constant, and ε_t is a white noise error term. The null hypothesis H0: $\beta = 0$ (unit root exists) is tested against the alternative H1: $\beta < 0$ (series is stationary). The lag length p is selected using the Akaike Information Criterion (AIC) to ensure that the residuals are free from serial correlation.

Along with the ADF test, I also use the Phillips-Perron (PP) test (Phillips & Perron, 1988). The PP test employs a non-parametric correction for the serial correlation and heteroskedasticity, which makes it more robust to such specification issues. The test adjusts the Dickey-Fuller t-statistic:

$$PP = t\beta \cdot (\frac{\sigma^2}{\lambda^2})^{\frac{1}{2}} \quad , \qquad (4)$$

where: $t\beta$ is the t-statistic from the simple Dickey-Fuller regression, σ^2 is the variance of the error term, and λ^2 is the long-run variance estimate using the Newey-West procedure. Consistency between ADF and PP results provides confidence in the stationarity findings. Rejection of the null hypothesis in both tests indicates stationarity in returns, which would contradict a pure random walk in price levels.

2.3.3. Autocorrelation tests

The random walk hypothesis implies that returns should be serially uncorrelated. The presence of significant autocorrelation in returns indicates predictability and thus represents a violation of market efficiency (Fama, 1970). The Ljung-Box Q-statistic (Ljung & Box, 1978) provides a formal test of the joint hypothesis that all autocorrelation coefficients up to *lag* m are simultaneously zero:

$$Q(m) = n(n + 2) \sum \left[\frac{\rho k^2}{(n-k)}\right] \quad , \qquad (5)$$

where: n is the sample size, ρk is the sample autocorrelation at lag k, and the summation is over k = 1 to m. Under the *null* hypothesis of no autocorrelation, the Q-statistic follows a chi-square distribution with m degrees of freedom. This study computes the Ljung-Box statistic for lags m = 5, 10, and 15 to test for both short-run and longer-term dependencies in returns.

2.3.4. Variance ratio test

The variance ratio test, developed by Lo & MacKinlay (1988), has become one of the most widely used and powerful tests of the random walk hypothesis. The test exploits a fundamental property of random walks: if returns are serially uncorrelated, the variance of k-period returns should be k times the variance of one-period returns. The variance ratio for holding period k is defined as:

$$VR(k) = \frac{Var[rt(k)]}{k} \cdot Var[r_t] \quad , \qquad (6)$$

where: $rt(k)$ denotes the k-period return from $t - k + 1$ to t, and rt is the one-period return. Under the random walk hypothesis, $VR(k) = 1$ for all k. Deviation from unity indicates predictability: $VR(k) < 1$ suggests mean reversion (negative serial correlation), while $VR(k) > 1$ indicates momentum or positive feedback trading (positive serial correlation).

Lo and MacKinlay (1988) derived test statistics under different assumptions. The homoskedastic test statistic assumes constant variance:

$$z(k) = \left(\frac{[VR(k) - 1]}{[\varphi(k)]}\right)^{\frac{1}{2}}, \quad , \quad (7)$$

where: $\varphi(k)$ is the asymptotic variance of the variance ratio under homoskedasticity.

The heteroskedastic-robust test statistic is:

$$z*(k) = \left(\frac{[VR(k) - 1]}{[\varphi*(k)]}\right)^{\frac{1}{2}}, \quad (8)$$

where: $\varphi^*(k)$ is the heteroskedasticity-consistent asymptotic variance. Both test statistics follow a standard normal distribution under the null hypothesis. Since financial returns typically exhibit time-varying volatility, the heteroskedastic-robust statistic is considered more reliable. This study computes variance ratios for k = 2, 4, 8, and 16 days, corresponding to approximately 2 days, 4 days, 1.5 weeks, and 3 weeks of trading.

2.3.5. Runs test

As a complement to the parametric tests described above, the non-parametric runs test provides a distribution-free method for testing randomness(Wald & Wolfowitz, 1940). A "run" is defined as a sequence of consecutive returns of the same sign (either all positive or all negative). Under the random walk hypothesis, the number of runs should follow a predictable distribution. Let N_+ denote the number of positive returns and N_- the number of negative returns. The expected number of runs under randomness is:

$$E(R) = 1 + \frac{2N_+N_-}{N_+ + N_-} \quad , \quad (9)$$

with variance:

$$Var(R) = \frac{2N_+N_-(2N_+N_- - N_+ - N_-)}{(N_+ + N_-)^2(N_+ + N_- - 1)} \quad . \quad (10)$$

The standardized test statistic is:

$$Z = \frac{R - E(R)}{\sqrt{Var(R)}} \quad , \quad (11)$$

where R is the observed number of runs. For large samples, this statistic approximately follows a standard normal distribution. Too few runs (negative Z-value) suggest positive serial correlation or trending behavior, while too many runs (positive Z-value) indicate negative serial correlation or mean reversion.

2.3.6. Analytical approach

By applying all the statistical tests described above to the return series of all 57 individual stocks and the ISX60 market index. This allows us to assess efficiency for each security, as well as for the market as a whole. Results for each test are provided at standard levels of significance (1%, 5%, and 10%) to gauge the evidence against the random walk hypothesis.

Instead of delivering findings individually for every stock, the examination presents summary metrics demonstrating the overarching trend across the sample. More precisely, a count of stocks failing to accept the random walk hypothesis for each level of significance is tabulated for every test. This serves to illustrate the extent to which the Iraqi equity market exhibits a lack of randomness. Furthermore, to evaluate the efficiency at a market level, the results pertaining to the ISX60 index are provided in detail.

In order to reinforce conclusions regarding market efficiency, the author checks the reliability of the results across different tests. The results obtained from multiple tests are more trustworthy than those obtained from a single test. The author conducted all the statistical analyses using the Python programming language, specifically using NumPy, Pandas, SciPy, and Statsmodels, which offer extensive implementations of the described econometric techniques.

3. Empirical results

This section provides empirical results after analyzing the random walk hypothesis for the entire 57 constituent stocks of the ISX60 index and for the market index itself. Based on the previously described methodology, the findings start with descriptive statistics, followed by more advanced analyses of market efficiency.

3.1. Descriptive statistics

Table 1 shows summary statistics for the daily returns of the 57 individual stocks and the ISX60 index. The daily return average across all stocks is –0.0041%, suggesting a slight average decline over the sample period. Daily average volatility across stocks is 3.21%, with substantial heterogeneity between 1.18% and 10.20%. The distributional characteristics are grossly non-normal, with a mean kurtosis of 171.98, which is much larger than the 3 expected under normality.

Table 1

Descriptive statistics of daily returns

Statistic	Mean	Std Dev	Minimum	Maximum	JB Reject, %
Mean return (%)	–0.0041	0.0446	–0.1234	0.0746	–
Volatility (%)	3.2068	1.7677	1.1840	10.1968	–
Skewness	0.2070	2.6373	–	–	–
Kurtosis	171.98	214.72	–	–	–
Normality (JB Test)	–	–	–	–	**100**
ISX60 Index	–0.0059%	1.62%	–1.32	107.31	Yes***

Note. Statistics represent cross-sectional means across 57 stocks.
*** indicates significance at 1% level.

The Jarque-Bera test formally rejects normality for all 57 stocks at the 1% level. The ISX60 index also strongly rejects normality (JB = 1 004 318, $p < 0.001$). This universal rejection suggests extreme events and non-standard distributions characterize Iraqi stock returns.

3.2. Unit root test results

Table 2 presents the results from the Augmented Dickey-Fuller test. All 57 stocks reject the null hypothesis of a unit root at the 1% significance level, indicating stationarity. The ISX60 index similarly exhibits strong stationarity.

Table 2

Augmented Dickey-Fuller unit root test results

Significance level, %	Stocks rejecting	Percentage, %
1	57 / 57	**100.0**
5	57 / 57	**100.0**
10	57 / 57	**100.0**
ISX60 Index	ADF = –16.55	p < 0.001***

Note. Null hypothesis: the series has a unit root (non-stationary).
*** indicates significance at 1% level.

While stationarity is consistent with a random walk in prices, it does not confirm the hypothesis. A random walk requires stationary and serially uncorrelated returns. Universal stationarity satisfies the first condition but requires further testing for serial independence.

3.3. Variance ratio test results

The variance ratio test offers strong evidence against the hypothesis of a random walk. *Table 3* shows the variance ratios for the 2, 4, 8, and 16-day holding periods. The mean variance ratios are less than one, which suggests mean reversion.

Table 3

Variance ratio test results

Period (k)	Mean VR	1% Reject	5% Reject	10% Reject	ISX60 VR
2 days	0.961	64.9%	73.7%	80.7%	0.747***
4 days	0.959	**70.2%**	**78.9%**	80.7%	0.603***
8 days	0.952	71.9%	77.2%	82.5%	0.548***
16 days	0.946	61.4%	70.2%	75.4%	0.532***

Note. Null hypothesis: VR(k) = 1. Rejection percentages based on 57 stocks.
*** indicates significance at 1% level.

At the 5% level, 70–79% of stocks reject the random walk hypothesis across all holding periods. The ISX60 index shows dramatic departures (VR = 0.53–0.75), indicating strong mean reversion in the aggregate market. These variance ratios–roughly half the expected value–represent substantial violations of market efficiency.

3.4. Runs test results

The non-parametric runs test complements parametric tests by examining randomness without distributional assumptions. *Table 4* presents the results. At the 5% level, 42.1% of stocks reject randomness, with 50.9% at the 10% level.

Table 4

Runs test results

Significance level	Stocks rejecting	Percentage	Mean Z-stat
1%	19 / 57	33.3%	—
5%	24 / 57	**42.1%**	–0.460
10%	29 / 57	50.9%	—
ISX60 Index	Runs: 824 / 950	$p < 0.001$***	–5.802

Note. Null hypothesis: returns are random. Negative Z-statistic indicates too few runs (positive correlation).
*** indicates significance at 1% level.

The mean Z-statistic of –0.46 indicates a tendency toward too few runs, suggesting positive serial correlation. The ISX60 index strongly rejects randomness ($Z = –5.80$, $p < 0.001$), with observed runs (824) substantially below expected (950), confirming momentum effects at the aggregate level.

3.5. Overall assessment

Table 5 synthesizes results across all tests at the 5% significance level. The evidence overwhelmingly indicates Iraqi stock returns do not follow a random walk. While all stocks exhibit stationarity, the vast majority show significant departures in serial correlation and predictability.

Table 5

Summary of random walk hypothesis tests
at 5% significance level

Test	Percentage Rejecting RWH
Unit root (ADF)	100.0% (stationary)
Variance ratio (k = 4)	78.9%
Runs test	42.1%
ISX60 Index	**Rejects in all tests*** **

Note. Rejection percentages based on 57 stocks.
*** indicates all ISX60 tests are rejected at 1% level.

The convergence of evidence across multiple methodologies – parametric and non-parametric – provides robust support that the Iraqi equity market is not weak-form efficient. The ISX60 index consistently rejects the random walk hypothesis across all tests, showing stronger violations than individual stocks. This suggests diversification effects or market-wide factors contribute to aggregate-level predictability, with strong mean reversion (VR ≈ 0.50–0.75) persisting across different time horizons.

4. Discussion

4.1. Interpretation of findings

The Iraqi stock market does not demonstrate weak-form market efficiency, which is the most reliable and consistent observation from the data. The random walk hypothesis has been conclusively rejected in a variety of statistical analyses, both at the level of individual stocks and at the level of the market as a whole. Although all stocks demonstrate stationarity- a condition necessary for random walk behavior- the widespread presence of serial correlation, mean reversion, and other predictable patterns demonstrates that prior price data is useful in predicting future returns. This result is in line with what one would expect of the Iraqi stock market, given the condition of many other so-called inefficient frontier markets. It is consistent with the expected theoretical condition for markets with poor liquidity, information divergence, and rudimentary institutional arrangements.

The ISX60 Index shows violations of the random walk hypothesis more than individual stocks, which is noteworthy. Compared to individual stocks having average mean values of individual stocks of about 0.95, the index shows variance ratios of 0.50 to 0.75. This means inefficiencies at the aggregate level are higher than at the individual security level. This result may be due to index tracking by institutions, aberrant sentiment, under or overreaction to macroeconomic info, or tracking by institutions.

4.2. Explanations for Market Inefficiency

Three main reasons can help understand why the Iraqi equity market operates inefficiently. First, sporadic trading and low market liquidity cause stickiness and serial correlation of market prices. Although in theory prices should adjust to new information, in practice, this gradual adjustment process can cause autocorrelation. Second, irrational retail behavior via herding, momentum trading, etc., leads to inefficient predictability in the prices via similar behavior in the market.

Third, in developed markets, information diffuses more efficiently than in frontier markets. There may be a lack of consistency in corporate disclosures, scant financial media coverage, and limited coverage of financial analysis. These barriers to information flow delay the price reaction to new information. Fourth, with respect to Iraq's oil price reliance, geopolitical issues, and weak institutions, the overall macroeconomic and political conditions may lead to widespread shocks and systematized patterns of returns as the markets slowly diffuse ambiguous information.

Finally, with no institutional investors and minimal foreign involvement, the market lacks the sophisticated arbitrageurs who usually act to remove any patterns that can be exploited. The absence of mechanisms for short-selling and no market for derivatives means that informed traders also face restrictions to arbitrage mispricings, and therefore, the market can be inefficient for arbitrage.

4.3. Comparison with other markets

The results are consistent with previous research on frontier and emerging markets. Research on other MENA markets demonstrates similar occurrences of weak-form efficiency violations, although in the magnitude of departure, there are significant differences. The Iraqi stock market, in comparison to Egypt and Jordan, seems to exhibit inefficiencies similar to or more than those of Jordan and Egypt. However, recent studies using the same methodologies and the same research questions are lacking, which makes benchmarking difficult. The differences in random walk behavior between the Iraqi market and more developed emerging markets such as Turkey or South Africa are considerable and validate the Iraqi market being classified as a frontier market rather than an emerging market.

4.4. Practical implications

The rejection of the random walk hypothesis implies that, at least before transaction costs, the frictionless environment allows investors to earn positive abnormal returns using technical trading strategies based on serial correlation, mean reversion, and the like. However, these strategies come with great execution and operational costs, the former of which are

particularly relevant for frontier markets. In addition, the descriptive statistics reveal extreme returns and high volatility, requiring significant risk and position sizing, which, to some, is considered operational risk.

The findings emphasize a few areas for improving market efficiency that policymakers and market regulators need to focus on first. It appears that improving market liquidity through market-making schemes, lowering transaction costs, increasing disclosure requirements, and encouraging institutional investors and the direct market potential of derivatives would help the market discover prices more efficiently. Increased and developed investor education would help in reducing the behavioral biases that strengthen predictable price patterns. Developing more efficient equity markets would improve capital allocation, corporate financing, and the greater economic development of Iraq.

The Iraqi market shows strong potential from an Academic standpoint, particularly focusing on the market microstructure and efficiency under extreme conditions. The market inefficiencies and the way information is adjusted in the Iraqi market can be investigated, given the market's substantial deviation from the random walk hypothesis. Using the Iraqi market as a study can help further understand the inefficiencies and information adjustment mechanisms within the context of a market with extreme institutional constraints.

Conclusions

The main hypothesis of the research, which in this case is that the daily stock returns of the Iraqi Stock Market are a random walk, and therefore demonstrates weak-form market efficiency, is contradicted by the evidence. From the period of August 2014 to August 2024, I was able to prove that the Random Walk Hypothesis is overwhelmingly and statistically significant at the 57 constituent stocks of the ISX60, as well as the Market Index. This is done by applying a uniform approach to the four converging methodologies, which are the unit root test, the Ljung-Box test, Lo-MacKinlay Variance Ratio tests, and the non-parametric runs tests. I was able to get 70–79% rejection at the 5% in the index level. The results are consistent in 57 constituent stocks of ISX60. This proves that weak-form market efficiency is not present in the Iraqi Stock Market.

This paper shows that the Iraqi Stock Exchange is able to demonstrate constructive inefficiency. Through the application of the random walk hypothesis to the 57 stocks in the ISX60, using daily record data from August 2014 to August 2024, rejections were received through multiple statistical processes. Stationarity was the only consistent characteristic of all stocks, but the majority also recorded high serial correlation, mean reversion, and predictability, which all contradict the random walk theory. The most noteworthy evidence was provided by the variance ratio tests. 70–79% of the stocks in the ISX60 provided evidence in support of the random walk theory, and even the index itself demonstrated a high level of inefficiency. The

results of this study fit the profile of previous studies done on frontier markets and also provided proof that, in the Iraqi equity market, prices from previous time periods held information that was useful in forecasting future returns.

The rejected weak form efficiency postulates that technical trading strategies based on pattern recognition and predictive mean reversion may lead to positive returns, although the high transaction costs associated with this particular marketplace may limit the potential for practical gains. These findings underscore the importance of prioritizing the development of marketplaces in Iraq, specifically in the implementation of market-making programs to enhance liquidity, lower transactional costs, increase the enforcement of mandatory disclosures, promote intermediation by financial institutions, and the growth of derivative markets. All of these efforts to improve the efficiency of the marketplace in Iraq will lead to more optimal allocation of resources, reduce the cost of capital for Iraqi companies, and promote economic development in the country.

Several constraints deserve to be noted. First, thin trading in the ISX may cause spurious autocorrelation due to stale prices; however, this reveals genuine market microstructure, and not a statistical artifact. Second, our tests center on linear relationships; non-linear relationships may be present, which are beyond the scope of our approach. Third, while high, we do not directly factor in the transaction costs in assessing profitability. Fourth, the sample period, while broad, may not be comprehensive of all market regimes or structural shifts in this developing frontier market.

Several avenues remain open to future research in this analysis. Understanding the determinants of efficiency would be enriched by examining whether the degree of inefficiency varies by industry or by the characteristics of the firm. This will be particularly informative for the evaluation of policy effectiveness in examining whether efficiency has changed over time, especially in the aftermath of policy reforms or changes in infrastructure. Analyzing the speed of information assimilation to test semi-strong form efficiency through event studies would be appropriate. Analyzing the profitability of trading strategies in the presence of realistic transactional costs would determine whether there are readily actionable trade-offs. Finally, research of a comparative nature across other MENA frontier markets would widen the scope of the study of the efficiency of the markets of Iraq. It is important, however, as markets of Iraq continue to approximate frontier status, that there be ongoing research to capture the emerging patterns of efficiency that will reflect the country's position within global capital markets.

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