Comparative Analysis of the capital market of Iran, Russia, Turkey, and Poland from the perspective of efficiency

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Abstract
This study conducts a comparative analysis of factors influencing capital market efficiency in Iran, Russia, Turkey, and Poland from 1975 to 2020. Data were sourced from the Tehran Stock Exchange, World Bank, World Federation of Exchanges database, and Global Economy website. Stock market efficiency was measured using Data Envelopment Analysis (DEA). Efficiency levels were compared with Iran's market via Mann–Whitney and Kruskal–Wallis non-parametric tests. Multiple regression analysis identified key factors affecting efficiency. Findings reveal that Iran's capital market ranks below Russia and Poland but above Turkey. While Iran lags in indicators such as stock market capitalization to GDP (SMC) ratio, stock market turnover (SMTR) ratio, and Stock Market Value Traded percent of GDP (SMVT), it leads in the stock market capitalization of the top ten companies (SMC10). Iran also outperforms Poland and Russia in stock market return percent (SMR) and stock market value traded of the top ten companies (SMVCT10), and surpasses Russia and Turkey in the number of listed companies (NC). This study contributes to theoretical foundations by elucidating Iran's capital market efficiency relative to similar emerging markets, highlighting its unique strengths and weaknesses across diverse metrics.

Keywords:
Capital Market Efficiency, Comparative Studies, Data Envelopment Analysis (DEA)

1. Introduction

Over the past decades, the efficiency of capital markets has been at the center of financial literature discussions due to its significant implications. Capital market efficiency is a crucial concept both in understanding the underlying mechanisms and in its functional contribution to a country's economic development; it facilitates the optimal allocation of resources and enables the use of prevailing market prices to foster efficient growth. From an investor's perspective, when a market does not fully adhere to the strong form of market efficiency, valuable insights can be gained by utilizing specific information and analysis to achieve excess returns. Furthermore, from a broader perspective, the reality that wealth transfers among individuals, where some gain substantial wealth through the stock market while others may lose everything, underscores the necessity of analyzing and explaining the current state of market efficiency and understanding the factors influencing it.

From another perspective, stock markets have become increasingly globalized. Although each market-oriented economy has developed its own distinct stock trading system to support its national economy, in today's interconnected and globalized world, global developments such as the shift toward a digital economy or geopolitical events have profound impacts on financial markets worldwide, with consequences often extending beyond the borders of the directly involved countries. Geopolitical events, including conflicts, trade disputes, natural disasters, and pandemics, have the potential to significantly affect financial markets, often triggering notable market-wide reactions. Recent examples include the COVID-19 pandemic (March 2020) and Russia's invasion of Ukraine (February 2022). The Russia-Ukraine war disrupted the global supply of energy products and wheat, leading to an increase in energy and wheat prices due to the critical roles of Russia and Ukraine as major producers and exporters. Consequently, energy and food industry indices in the stock exchanges of other countries were also affected[1]. In this regard, the

[1] For example, the most populous countries in Africa (Nigeria, Egypt, Sudan, Kenya, Tanzania, and South Africa) import more than half of their wheat supply from Russia.

findings of Agung et al. (2023) indicate that geopolitical threats peaked following the Russian invasion of Ukraine, potentially influencing trade, financial intermediation, capital raising, inflation, and a slowdown in economic growth. Therefore, exploring the mechanisms of capital markets in influential countries and expanding the scope of currently fragmented studies to cross-national analyses becomes even more essential.

Recently, emerging and fast-growing stock markets such as Turkey and Russia (a BRICS member) have attracted significant attention from researchers and investors. Russia's economic system, similar to that of Iran, operates under a state-private hybrid model, where certain strategic sectors such as energy and power remain under full government control. In terms of economic structure, in both countries, the services, industry, and agriculture sectors represent the largest shares of national production. Additionally, oil revenues play a critical role in government budgets. Both economies also follow an energy-driven growth model, with oil and gas revenues forming the foundation for exports, government income, employment, and investment. Russia is the world's largest producer of oil (accounting for 14% of global production), natural gas (18% of global production), and nickel (12% of global production). The energy sector is the most critical component of Russia's economy, accounting for 20% to 25% of Gross Domestic Product (GDP), 65% of total exports, and 30% of government revenues. Russia also holds a significant position in global trade balances; for example, in 2020, Russia supplied 46.7% of Europe's total solid fuel imports, 41.1% of its natural gas consumption, and 27% of its crude oil imports (Eurostat, 2022). Among the countries in the region, Turkey has succeeded in establishing extensive economic relations with Russia, whereas Iran, despite sharing a maritime border with Russia, is not considered a major economic partner of the country[2]. Turkey, which is ranked among the world's top twenty economies, accounted for approximately 1.2% of global trade in 2022. In contrast, Iran's share of global trade fell to 0.24% in 2022 (corresponding to 1401 in the Iranian calendar), marking the lowest level in Iran's history. In Turkey, dynamic and robust trade relations with the global economy, driven by private sector enterprises exporting finished goods, have contributed significantly to the country's rise in foreign trade.

The transformation of former communist countries in Europe, which began more than 25 years ago, has led to their reintegration into the global economy and significant improvements in living standards. Although the liberalization of trade and prices was relatively straightforward and executed rapidly during this transition, institutional reforms in areas such as governance, competition policy, labor markets, privatization, and corporate restructuring proved to be more challenging due to resistance from vested interests. During the communist era, financial systems in Central and Eastern Europe played a largely passive role. However, throughout the transition period, significant structural changes were implemented in the banking sector, regulatory and accounting standards were enhanced, and the tax system was modernized, shifting toward income and value-added taxation models. Although the capital markets in post-communist countries such as Poland have a relatively short history, they adopted solutions from developed economies, which has fundamentally changed their position within Europe. The stock exchanges of the Baltic countries belong to NASDAQ OMX Nordic and form the Baltic market, while the exchanges of Budapest, Ljubljana, and Prague have joined forces with the Vienna Stock Exchange. The Warsaw Stock Exchange has the largest capital market among the transitioning European economies.

[2] For example, in 2022, Russia had imports worth approximately 286 billion and 650 million dollars, with Turkey ranking 21st (accounting for 1.7% of this total) in exports to Russia, totaling 4 billion and 869 million dollars. Additionally, Iran ranks 69th with exports to Russia worth 260 million dollars. In other words, Iran's share of the Russian market is less than 0.1%, while Turkey's exports to Russia are 19 times greater than Iran's.

Although it is not possible to assess and compare the efficiency of capital markets in different countries with a single mechanism, it can be noted that the Iranian stock market has experienced significant fluctuations in recent decades. A large portion of these fluctuations can be attributed to governance policies based on a mixed economy system (public-private) and regional geopolitical issues. These features have similarly affected some neighboring countries, such as Russia and Turkey. Therefore, considering the overall economic conditions in these countries, a comparative study can help identify the position and situation of the capital market, as well as the opportunities and threats it faces, based on the market efficiency components. This research gap has led scholars to conduct a comparative study to explore the factors affecting the efficiency of the Iranian capital market, comparing it with emerging economies, especially Russia and Turkey (as neighboring trade partners with their specific economic conditions), and Poland (as the largest post-communist European stock exchange). The study specifically addresses the following questions:

1. How does the efficiency of the Iranian capital market compare to the selected countries (Russia, Turkey, and Poland)?
2. What differences exist in the impact of components on the efficiency of the Iranian capital market compared to the above-mentioned selected countries?

In this context, and given the limitations in obtaining homogeneous data from the studied stock exchanges, the efficiency of the Tehran Stock Exchange was compared with the stock exchanges of the selected countries over the period from 1975 to 2020, and the effective components were analyzed. It is evident that the results of this research, in addition to advancing and expanding the academic scope of the related field, also have practical objectives aimed at improving the efficiency of the Iranian capital market and ensuring the optimal allocation of resources, considering the geographical scope of the studied sample.

2. Literature review

Financial markets, as channels for directing financial resources from non-productive sectors to productive sectors, play a vital role in economic growth, development, and the improvement of societal welfare. While the Efficient Market Hypothesis (EMH) proposed by Fama (1970) focuses on informational efficiency (i.e., prices fully reflect available information in weak, semi-strong, or strong forms), the DEA approach adopted here measures the technical and operational efficiency of capital markets viewed as production units. Specifically, DEA evaluates how efficiently markets transform liquidity-related and structural inputs (such as turnover ratio and trading value) into desirable market outcomes (such as market size and returns). As such, DEA-based efficiency captures relative productive and operational performance rather than pure informational efficiency. This distinction is important, as DEA-based efficiency reflects structural and institutional characteristics influenced by market development, regulatory environments, and geopolitical shocks, thereby complementing—rather than directly testing—the EMH framework. Consistent with prior applications of DEA in evaluating financial market and portfolio performance (e.g., Lim et al., 2014; Peykani et al., 2024; Basso & Funari, 2016), DEA provides a non-parametric benchmark for assessing relative performance in emerging and transition markets where parametric EMH tests may be less applicable due to data limitations and structural heterogeneity. This DEA-based perspective is particularly valuable for comparing structurally heterogeneous emerging markets such as Iran, Russia, Turkey, and Poland, where institutional characteristics and geopolitical conditions are likely to shape market structure and operational performance. In financial economics literature, the capital market plays a fundamental role in economic growth through providing financing for businesses, optimal allocation of resources, enhancing asset liquidity, improving corporate governance, and increasing transparency in the economy (Robati et

al., 2023). Compared to developed countries, the Iranian economy and, consequently, its capital market, possess unique characteristics that distinguish them. The main difference between the Iranian capital market model and those of developed economies lies in Iran's use of its strong government power to regulate the economy, undertake numerous capital projects, and establish powerful state-owned organizations. Additionally, the Iranian stock market faces more limitations, such as a lack of variety in tradable securities and limited opportunities for cross-border investments. While the Iranian capital market offers strong investment opportunities, it suffers from low market efficiency due to several factors, such as a low security level for foreign investors, which makes it difficult to guarantee sustainable and healthy market development. This issue is compounded by the delayed development of the legal system, and even if legal reforms are undertaken to support the stock market, rapid market growth can render these reforms ineffective. In terms of financing resources, the credit system favors larger firms. Due to insufficient regulatory measures to rate companies' credit, the potential for major shareholders to exploit small and medium shareholders increases. Many large shareholders often leverage their capital power, legal control over key company assets, and quick access to informational advantages to gain excess profits.

In general, there is a direct relationship between the level of stock market development in a country and its economic development[3]. In this regard, studying the status and identifying the factors and indicators influencing the stock market are crucial for providing well-founded solutions for its regulation and development. The development of the stock market is influenced by various factors. The literature identifies negative factors affecting stock market development, including high volatility of the national currency, dependence on raw materials, fluctuations in interest rates, foreign sanctions, geopolitical factors, and international conflicts.

Borsch (2018) analyzed the Russian capital market and identified key factors influencing the development of its stock market, including major global economic events such as the 2008 financial crisis, international political relations, and domestic and foreign policies. These findings indicate that global economic and geopolitical instabilities significantly impact the dynamics of the Russian stock market, providing valuable insights for comparative analyses with other emerging markets.

Saputra et al. (2023) conducted a comparative study of Sharia stock indices in Indonesia, Turkey, China, and Malaysia. In this study, they examined the long-term and short-term effects of the relationship between the Dow Jones Islamic Market Turkey Index (DJIMTR), Dow Jones Islamic Market China/Hong Kong Index (DJICHK), and Dow Jones World Islamic Market Malaysia Index (DJMY25) against the Indonesian Sharia Stock Index (JKISSI) using a vector error correction model from January 2016 to May 2022. The results of the study indicate that in the short term, none of the independent variables have a significant impact on JKISSI, but in the long term, DJIMTR and DJICHK have a significant negative effect on JKISSI. Additionally, DJMY25 has a significant positive impact on JKISSI. Memon et al. (٢٠٢٤) studied the efficiency of capital markets in the G20 group. To this end, they classified and conducted a comparative analysis of stock market indices using MSCI[4] for developed and emerging markets, employing the Multifractal Detrended Fluctuation Analysis (MFDFA) method. The findings indicated that all G20 stock markets displayed multifractality, and there were long-term correlations in volatility across these markets. Italy was found to have the lowest return, while Germany had the most

[3] Examples of this include the New York Stock Exchange - the U.S. economy, the Tokyo Stock Exchange - the Japanese economy, and the Frankfurt Stock Exchange - the German economy

[4] Morgan Stanley Capital International

efficient stock market. Ultimately, the efficiency of developed stock markets outperformed that of emerging markets.

Saâdaoui (2023) examined the impact of the COVID-19 pandemic on the efficiency of capital markets (using asymmetric multifractal scaling) and analyzed the financial indices of the G3+1 countries (including the United States, Japan, the Eurozone, and China). The findings indicated that market failures occurred at different times across all indices. For the U.S., Japan, and the Eurozone markets, the turning point was marked by an increase in fractal levels, which corresponded with a structural breakdown and a shift to a period of heightened volatility. In contrast, the Chinese market experienced a reduction in multifractal levels, as authorities successfully implemented their policies to manage the COVID-19 health crisis, resulting in a period of calm and low volatility after the turning point.

The results of Memon et al. (2022) regarding the efficiency of six clean energy markets indicated that, overall, TXCT and BSEGRNX[5] were the most efficient clean energy markets. However, the ranking of TXCT[6] significantly worsened in shorter periods. Multifractality and the symmetry of mass behavior were also intensified during periods of crises.

Zaheer et al. (2024) examined the relationship between global financial markets during the Russia-Ukraine conflict and found a strong correlation between the markets under study during the invasion period, compared to the period before the invasion.

Smith (2024) examined the impact of geopolitical events, such as the Iraq invasion and ongoing Middle East tensions, including the Israel-Palestine conflict, on stock markets. The study found that developed financial markets, such as the S&P 500, exhibited heightened volatility at the beginning of the Iraq War in 2003 due to political instability and oil supply concerns.

Yousaf et al. (2022) examined the impact of the Russia-Ukraine conflict on G20 countries and other selected stock markets using an event study approach. The analysis of abnormal returns (AR) before and after the onset of military operations, particularly by Russian military forces on February 24, 2022, showed the severe negative impact of this military action on most stock markets, especially the Russian stock market. The cumulative stock market analysis indicated a significant and negative impact of the Russia-Ukraine conflict on the event day and the days following the event. The step-by-step country analysis revealed that the stock markets of Hungary, Russia, Poland, and Slovakia initially reacted to the military actions in Ukraine, showing negative returns in the days leading up to the event. However, the stock markets of Australia, Germany, India, Italy, Japan, Romania, South Africa, Spain, and Turkey, on the other hand, were impacted by the war in the days following the invasion. Finally, the regional analysis indicates that European and Asian regions were significantly and adversely affected by this event.

Charfeddine and Khediri (2016) examined the weak efficiency of the stock markets in the Gulf Cooperation Council (GCC) countries and concluded that, while the GCC market has varying degrees of efficiency over time, it is improving. They ranked Qatar as the most efficient market and Bahrain and Oman as the least efficient.

Ramazanov (2022) states that to determine the efficiency of the capital market, various indicators such as the number of brokerage accounts, trading volume, volume of securities issuance, and the savings rate of the population are considered. Additionally, he mentions that for a comprehensive analysis of the development level of regional stock markets, a group of indicators can be used, such as the socio-economic status of the region, the number of dynamic business organizations in the area, the dynamics of registering new public joint-stock companies, the volume of issuance in

[5] S&P BSE GREENEX

[6] S&P/TSX Renewable Energy and Clean Technology Index

the primary stock offering market, and quantitative features of the secondary securities market (such as the number of issuers, professional market participants like brokers, traders, and institutional and private investors).

The comparative analysis by Petry et al. (2023) of securities exchanges in six emerging market economies, including Brazil, China, India, Russia, South Africa, and South Korea, indicated that in most advanced economies, exchanges operate within an institutional environment that follows neoliberal institutional logic. Additionally, exchanges in emerging markets often serve the function of facilitating government objectives through the organization of capital markets.

Miloş et al. (2020) conducted a study on seven stock markets in Central and Eastern Europe. Their results confirmed a long-term correlation and, at the same time, provided evidence of inefficient stock markets.

Topcu and Gulal (2020) compared the impact of the COVID-19 pandemic on emerging stock markets, including Turkey and Russia. The results indicated that the Turkish stock market (BIST-100) performed better compared to the Russian stock market (MOEX) during the pandemic.

Kovalevich (2018) states that the investment indices of the stock exchanges in the Eurasian Economic Union (EAEU) are significantly influenced by the refinancing rate, inflation rate, and the exchange rate of the U.S. dollar to national currencies. Furthermore, to assess the level of development of capital markets, he considered trading volume and the number of shareholders. The scholar's positions primarily encompassed either external economic and political factors (such as exchange rates and economic sanctions) or the outcomes of trading activities (such as trading volume and market value).

Ali et al. (2018) conducted a comparative analysis of the efficiency of developed capital markets and 12 Islamic stock markets using multifractal detrended fluctuation analysis (MFDFA). The results indicate that developed markets (the United States, Japan, and Hong Kong) are more efficient, followed by the BRICS stock markets. The comparative efficiency analysis shows that almost all stock markets, except for Russia, Jordan, and Pakistan, are more efficient than their counterparts, such as Turkey, the United States, and China. This suggests the relative newness of Islamic stock markets; however, their specific nature, Sharia-compliant regulations, good governance, and disclosure mechanisms make them more efficient. Furthermore, the results suggest that the adjustment of Islamic stock markets with speculative activities is, in fact, higher than their conventional counterparts.

Ikeda (2018) utilized the MFDFA method to assess the resilience of Russia's stock market to financial crises. His findings not only revealed multifractal structures in the Russian stock market but also highlighted the market's severe conditions during the 1998 Russian crisis and the 2008 global financial crisis. Similarly, Arshad et al. (2016) evaluated the efficiency of stock markets in eleven member countries of the Organization of Islamic Cooperation (OIC) and found higher efficiency during economic booms compared to lower efficiency during periods of crisis.

Hammoudeh and Li (2008) analyzed the impact of the Iraq invasion and Middle East political instability, including the Israel-Palestine conflict, showing that political instability had a significant impact on global financial markets, particularly at the beginning of the Iraq war. Additionally, Alam et al. (2016) conducted a comparative analysis of ten global and Islamic stock indices. Their results indicated higher efficiency in Islamic sector indices compared to conventional stock indices.

In the field of domestic studies, Robati et al. (2023) conducted a comparative analysis of the components of the capital markets in Iran, Singapore, Malaysia, Turkey, and India across three dimensions: macroeconomic policies, financial development, and institutional quality, covering

the period from 2000 to 2021. In terms of macroeconomic policy, the findings indicated that an increase in GDP served as a strong driver for capital market development in the selected countries. A low inflation rate contributed to a stable macroeconomic environment in Singapore, Malaysia, and India, fostering favorable conditions for capital market growth. Furthermore, the existence of a fiscal surplus in Singapore and the absence of significant budget deficits in Malaysia, Turkey, and India created a macroeconomic climate conducive to capital market expansion. Accordingly, in terms of the impact of macroeconomic policy on capital market development, Iran ranked weak, Malaysia, Turkey, and India ranked moderate, and Singapore ranked strong. The development of the financial sector, through both the banking system and financial institutions, as well as the degree of financial openness, also played a critical role in capital market performance. Among the countries studied, Iran exhibited the weakest performance, while Turkey and India were positioned at a moderate level. Singapore and Malaysia demonstrated strong performance in this area. The strength of core institutions influences capital market development and, in turn, economic growth and development through two main channels: legal protection of investors and the rule of law. Based on indicators related to institutional strength, Iran exhibits the weakest institutional quality, while Singapore and Malaysia benefit from high-quality institutions. Turkey and India fall within the moderate range in terms of institutional performance.

Khatami et al. (2023), using wavelet analysis, demonstrated that over time, the volatility range of the overall stock market index in MENA (Middle East and North Africa) countries has increased. Based on the results of a Vector Autoregression (VAR) model and Granger causality tests, the Iranian stock market was found to be unilaterally influenced by fluctuations in the stock markets of Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates, and Lebanon. This means that any volatility occurring in the stock markets of these countries is immediately transmitted to the Iranian stock market. In contrast, there was no evidence of spillover effects from the stock markets of Jordan, Bahrain, or the North African countries namely Egypt, Tunisia, and Morocco on Iran's stock market. Furthermore, quantile regression analysis revealed that the degree of Iran's stock market sensitivity to external fluctuations varies across different countries and quantiles. Specifically, in months when stock market volatility in those countries was low, the impact on Iran's market was minimal, whereas in months with significant volatility, a greater degree of fluctuation was transmitted to Iran's stock market.

In a study by Nasrollahi et al. (2018), the primary focus was on modeling volatility transmission among the stock markets of Iran, Turkey, and India. To this end, a multivariate GARCH model was developed to examine the spillover effects between the price indices of the respective markets. The interrelationship among the Iranian, Turkish, and Indian stock markets was analyzed using daily stock price data from the period 2007 to 2013, employing the BEKK-GARCH model (Engle and Kroner[7], 1995). The results indicated a significant autoregressive structure within each market: past shocks had a statistically significant impact on future volatility within their own markets for all three countries. In other words, the ARCH and GARCH coefficients were significant for Iran, Turkey, and India, implying that stock market volatility in each of these countries was strongly influenced by its own past volatility. However, no evidence was found of volatility spillover between the Iranian stock market and those of Turkey or India. Specifically, there was no significant volatility transmission from Iran to Turkey or vice versa, and the same was true for the relationship between Iran and India

In a comparative study by the World Federation of Exchanges (2017), the capital market of Iran was evaluated alongside those of ten neighboring countries or financial markets, including Turkey,

[7] Angel & Keroni

Saudi Arabia, Qatar, Bahrain, Jordan, Egypt, Cyprus, Kazakhstan, and the financial markets of Dubai and Abu Dhabi. In this study, key stock market indicators were assessed using official statistics reported to the Federation of International Stock Exchanges as of January 2017. One of the primary metrics for comparison was market size, measured by market capitalization. Among the eleven countries analyzed, Saudi Arabia held the largest market capitalization, exceeding $442 billion, which represented approximately 69% of its GDP, a high ratio that was generally observed among most Gulf Cooperation Council (GCC) countries. In contrast, Iran's SMC stood at $98 billion, equating to just 23% of its GDP. The lowest market capitalization among the countries studied was reported for Cyprus, at only $2 billion. Another key indicator was the value of traded shares, where Turkey and Saudi Arabia led with the highest transaction volumes. Moreover, the turnover ratio defined as the ratio of total trading value to total market capitalization also showed a significant disparity. In Turkey, this ratio exceeded 200%, highlighting high market liquidity and dynamism. In contrast, Iran's turnover ratio was only 10%, indicating low liquidity, limited market activity, and reduced stock tradability compared to larger regional markets. On the other hand, Iran reported a higher number of listed companies than many of the other countries examined. This was largely attributed to privatization policies and the divestiture of state-owned enterprises, which led to an increased number of firms being listed on the stock exchange.

3. Methodology

The primary objective of this study is to conduct a comparative analysis of the capital markets of Iran, Russia, Turkey, and Poland, with a particular emphasis on the key determinants of market efficiency. To achieve this objective, the capital markets of the aforementioned countries are compared using various statistical methods, focusing on the factors influencing market efficiency. In the first stage, the factors affecting the stock market efficiency in the selected countries are identified and measured using data derived from eight specific variables (Table 1). The variables SMC10 and SMVCT10 were developed to assess market concentration, building on standard financial metrics from Demirgüç-Kunt and Levine (1996) and Yartey (2008). This assessment is conducted by drawing on the methodologies and frameworks proposed in previous studies by Demirgüç-Kunt and Levine (1996), Yartey (2008), Kovalevich (2018), and Ramazanov (2022). EF captures operational and scale efficiency—that is, the ability of capital markets to transform observable inputs (liquidity and trading activity) into outputs (market size and returns). It does not measure informational efficiency (Fama, 1970) or allocative efficiency. This operational perspective, aligned with the financial development literature (Demirgüç-Kunt & Levine, 1996; Yartey, 2008), ensures comparability across heterogeneous economies through standardized, ratio-based metrics. EF thus provides a relative benchmark of operational performance within the defined input-output framework. We quantify EF using Data Envelopment Analysis (DEA), a non-parametric linear programming approach suited for benchmarking multiple decision-making units. The selection of inputs and outputs in the DEA model is grounded in established financial development literature and prior empirical studies on stock market performance (e.g., Demirgüç-Kunt & Levine, 1996; Yartey, 2008; Ramazanov, 2022). Inputs include SMTR and SMVT, which represent liquidity conditions and trading activity as key resources utilized by capital markets. These variables capture both the intensity of market transactions and the extent to which economic resources are mobilized through trading. Outputs consist of SMC and SMR, reflecting market size (depth and development) and investor attractiveness (performance), respectively. This input–

output structure conceptualizes capital markets as production units that transform liquidity and trading activity into larger market scale and improved return performance, consistent with the role of liquidity in fostering market development and efficiency in emerging economies. Potential conceptual overlap between liquidity-related inputs (SMTR and SMVT) and size or performance-related outputs is acknowledged, as higher trading activity may be associated with greater market capitalization. To address this concern and assess robustness, an alternative DEA specification excluding SMVT as an input was considered. The resulting efficiency estimates exhibited a high degree of consistency with the baseline model, and the relative efficiency rankings across countries (Russia > Poland > Iran > Turkey) remained unchanged. This evidence suggests that the main findings are not driven by a specific choice of liquidity-related input variables. The evaluation of market efficiency is carried out using the Data Envelopment Analysis (DEA) approach. It is important to note that, due to limitations in data availability across different countries during the study period, only variables for which consistent and reliable data existed were selected for analysis. The calculated efficiency scores, obtained through DEA, were then compared with Iran's stock market efficiency using mean comparison methods. Specifically, the Mann–Whitney U test was used for pairwise country comparisons, while the Kruskal–Wallis test was applied for comparing all countries collectively. Subsequently, the key factors influencing the efficiency of the stock markets in Iran and the selected countries were analyzed using multiple regression analysis. Data were collected through documentary research, drawing on official reports from the Tehran Stock Exchange Organization, the World Bank, the World Federation of Exchanges (WFE) database, and the Global Economy website[8]. Furthermore, due to constraints in data collection, the study period was generally set from 1975 to 2020. For countries where complete data were not available throughout the entire period, the analysis was based on the available sub-period. In cases where missing data were encountered, the mean substitution method was used, whereby missing values were replaced with the mean of the corresponding variable.

A limitation of the present study relates to the treatment of missing observations over the extended sample period (1975–2020). Due to cross-country data availability constraints and the objective of maintaining a balanced panel for comparative analysis, missing values were replaced using mean substitution. While this approach facilitates consistency in cross-country comparisons, it may reduce variability and potentially bias efficiency scores and regression estimates. To mitigate this concern, a robustness check was performed by re-estimating the DEA model and non-parametric tests over a restricted sub-period (2000–2020) with more homogeneous data coverage. The results confirm that the relative efficiency rankings and key significant differences remain consistent with the full-sample findings. Accordingly, the findings should be interpreted as indicative of relative efficiency patterns rather than precise point estimates. A principal limitation of this long-horizon comparative analysis arises from the incomplete availability of standardized financial data for all four countries over the 1975–2020 period. Despite exhaustive efforts to gather data from international sources (e.g., World Bank, World Federation of Exchanges), certain annual observations remained unavailable. To maintain a balanced panel—essential for the DEA and comparative statistical tests—missing values were imputed using mean substitution, a common recourse in cross-national financial studies facing similar data gaps (e.g., Henry, 2000; Bekaert et al., 2005; Little & Rubin, 2002). While our robustness checks using the more complete post-2000 sub-period confirm the stability of the core comparative findings (i.e., relative efficiency rankings),

[8] The Global Economy.com

this imputation approach inherently reduces estimated variance and may smooth structural volatility in the earlier decades. Therefore, interpretations regarding the absolute magnitude and short-term fluctuations of efficiency trends prior to 2000 should be made with caution. The primary strength of our analysis lies in its cross-country comparative perspective over an extended timeframe, rather than in the precise estimation of each country's uninterrupted historical volatility path. Future research may further address this limitation by employing alternative imputation techniques, such as linear interpolation or multiple imputation.

Table 1. The variables used in the current study along with their respective measurement methods.

Symbol	Variable	Definition	Variables calculation
SMC	Stock Market Capitalization as percent of GDP	The total market capitalization (stock exchange capitalization) is defined as the price of securities at the end of the period multiplied by the total number of securities issued (for companies listed on the national stock exchange of each country)[1], divided by GDP**.** Investment funds**,** investment units, and companies whose sole business purpose is to hold shares of other listed companies are excluded from this calculation. This ratio is one of the indicators of capital market development in countries.	$\text{SMC} = \frac{SP \times NP}{GDP} \times 100$ SMC: Stock Market Capitalization SP: Price of securities NP: Number of securities in the stock market GDP: Gross domestic product
SMCB	Stock Market Capitalization Billion USD	Stock Market Capitalization (SMC), expressed in billion USD, is calculated as the market price of listed securities at the end of the period multiplied by the number of outstanding shares (for domestically listed companies). The conversion to USD is based on the end-of-period exchange rate.	$\text{SMCB} = SP \times NP$ SMCB: Stock Market Capitalization SP: Security Price NP: Number of Shares Outstanding
SMTR	Stock Market Turnover Ratio	The turnover ratio is calculated as the total value	$\text{SMTR} = \frac{VST}{MC} \times 100$

		of domestically traded securities divided by the total stock market capitalization, expressed as a percentage. To obtain the annual turnover ratio, the monthly average is multiplied by 12. This ratio reflects the level of activity in the stock market. A higher turnover ratio indicates greater stock circulation and a more active market.	SMTR: Turnover rate VST: Value of domestic securities traded MC: Total value of the stock exchange
NC	The number of companies	Domestically listed companies[2] are those that have shares listed on the stock exchange at the end of the year. Investment funds, banks, and companies whose sole commercial purpose is to hold shares of other listed companies, such as holding companies and investment firms, are excluded from this category.	---
SMVT	Stock Market Value Traded percent of GDP	Transaction value is calculated as the total number of securities traded, both domestic and foreign[3], multiplied by their corresponding market prices, divided by the gross domestic product (GDP). In this variable, companies listed and approved for trading are included in the data. The data represents end-of-year values.	$\text{SMVT} = \frac{SP \times NPT}{GDP} \times 100$ SMVT: Transaction value NPT: Total number of traded shares of companies SP: Stock price
SMR	Stock Market Return percent		
SMC10	Stock Market Capitalization of the top ten companies		
SMVCT10	Stock Market Value Traded of the top ten companies		

4. Results

4.1. Descriptive Statistics of Research Variables

Table 2 presents the descriptive statistics of the study's quantitative variables, disaggregated by country. According to the data, the average ratio of Iran's SMC is 39.24%, which is higher than that of countries such as Poland and Turkey, but lower than Russia's. The average SMCB for Iran is 112.47 billion USD, which exceeds that of Poland but falls short of the figures for Russia and Turkey. The average SMTR ratio in Iran is 16.91%, which is lower than that of all other countries in the sample. The average NC in the Iranian stock exchange is 304, which is fewer than Poland but greater than Russia and Turkey. Finally, the average SMR in Iran is 56.11%, which is similar to that of Turkey and higher than both Russia and Poland.

Table 2. Descriptive statistics of research quantitative variables

Variable	Country	Maximum	Minimum	Mean	Standard Deviation	Number
SMC	Iran	508.22	2.02	39.2479	94.51398	28
	Russia	62.38	18.74	41.4925	8.14300	28
	Poland	49.33	3.21	25.4915	12.17829	26
	Turkey	43.96	12.19	25.1475	8.68017	28
SMCB	Iran	1218.39	1.29	112.4718	232.4492	28
	Russia	951.30	385.93	681.6342	108.7013	28
	Poland	211.62	4.56	108.1488	71.94429	26
	Turkey	315.20	20.77	142.2254	90.92268	28
SMTR	Iran	37.96	5.85	16.9146	7.64649	28
	Russia	70.73	22.83	39.2608	10.59490	28
	Poland	66.20	11.43	40.1865	13.50318	26
	Turkey	365.77	43.70	159.9639	64.64138	28
NC	Iran	408.00	119.00	304.2500	72.08874	28
	Russia	592.00	21.00	268.7857	188.9762	28
	Poland	872.00	65.00	477.5385	307.2061	26
	Turkey	392.00	160.00	277.1071	63.05221	28
SMVT	Iran	192.90	.33	36.03469	10.4000	28
	Russia	98.25	7.77	20.31649	25.4995	28
	Poland	21.02	1.63	4.74816	9.5892	26
	Turkey	120.59	8.87	19.79889	38.6975	28
SMR	Iran	187.08	-21.91	56.11107	42.5145	28
	Russia	78.88	-53.51	22.03005	11.6750	28
	Poland	67.59	-31.66	23.76102	5.2058	26
	Turkey	197.59	-29.83	56.16316	41.8832	28
SMC10	Iran	68.10	13.64	55.0430	55.0430	28
	Russia	40.27	30.75	36.6945	36.6945	28
	Poland	48.64	29.27	39.4732	39.4732	26
	Turkey	61.16	40.03	51.0696	51.0696	28
SMVCT10	Iran	80.73	21.26	11.99390	51.7432	28
	Russia	99.82	3.72	16.63967	22.8209	28
	Poland	61.29	18.17	10.20902	38.6343	26
	Turkey	68.82	38.07	6.86739	52.2683	28

4.2. Estimating Stock Market Efficiency in Iran and Other Countries

To evaluate the factors influencing the efficiency of the stock markets in Iran and other countries, DEA is employed. The input variables used in the analysis include the SMTR ratio (i.e., value of

domestic securities traded divided by total value of the stock exchange) and the SMVT. The output variables consist of SMC and the SMR (%). Using these input and output variables, the stock market efficiency of Iran and the other countries in the sample is calculated through the R programming language, specifically using the *dea* function from the rDEA package. Table 3 presents the descriptive statistics for the efficiency-related variables across the sampled countries. The average calculated efficiency score for Iran is 0.6533. This score indicates that, based on the selected criteria, Iran's stock market is more efficient than Turkey's, but less efficient than the stock markets of Russia and Poland. Figures 1 to 3 illustrate comparative charts of Iran's stock market efficiency relative to the other countries in the sample.

Table 3. Descriptive statistics of efficiency

	Maximum	Minimum	Mean	Standard Deviation
Iran	1.00	.20	.6533	.27662
Russia	1.00	.34	.7569	.19708
Poland	1.00	.28	.7520	.24590
Turkey	1.00	.15	.4091	.23049

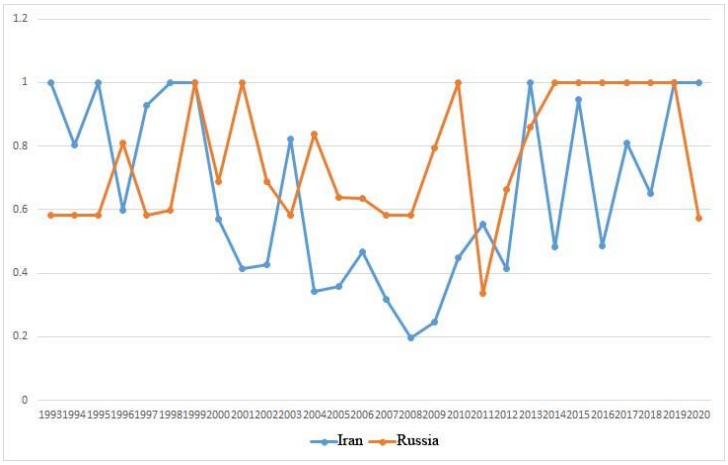

Figure 1. Comparison of efficiency of Iran and Russia

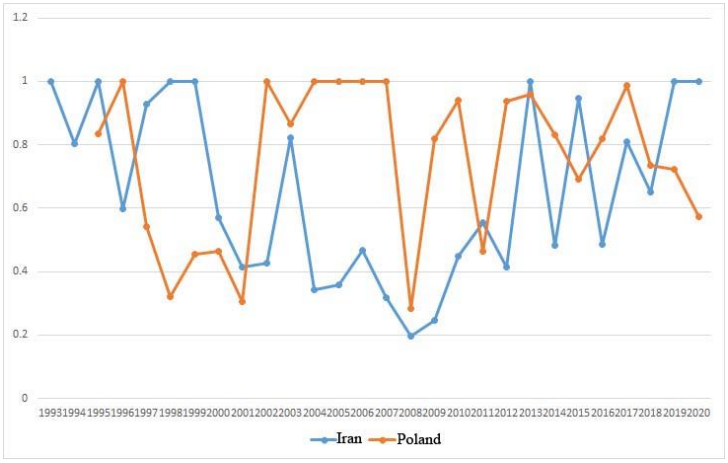

Figure 2. Comparison of efficiency of Iran and Poland

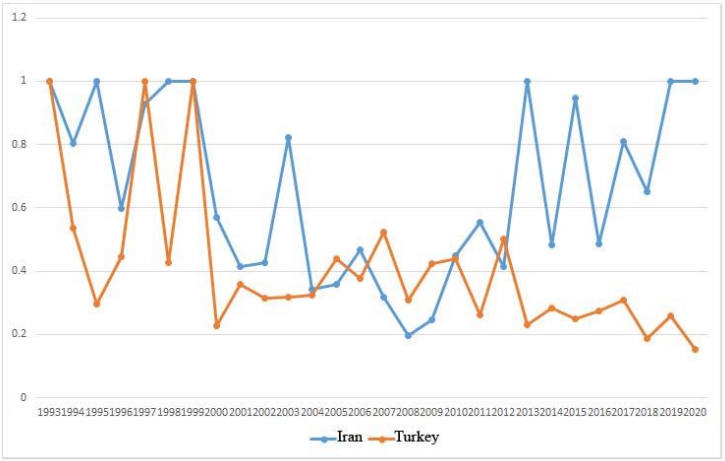

Figure 3. Comparison of efficiency of Iran and Turkey

As illustrated in Figure 1, the decline in the efficiency of Iran's capital market between 2000 and 2012 created a significant gap compared to the Russian capital market. However, following this period, Iran's market efficiency gradually improved, and the gap began to narrow until 2020, when Russia's market efficiency experienced a sudden drop. Between 2014 and 2019, Russia's

efficiency levels remained relatively stable and consistently high. Key political events affecting Russia during this period include: The annexation of Crimea and the severance of relations with NATO in 2014, EU sanctions imposed on Russia and the subsequent depreciation of the Ruble against the U.S. dollar, Russia's accession to the World Trade Organization (WTO) in 2011, The recognition of Russia as a high-income economy in 2013, and Withdrawal from the Intermediate-Range Nuclear Forces (INF) Treaty in 2019, following the U.S. decision. In Figure 2, aside from the period 1996 to 2001, during which Iran's capital market was more efficient than Poland's, Poland's market efficiency shows an upward trend from 2001 until 2007, followed by a notable decline in 2007, and then a recovery in 2008–2009. Although fluctuations in Poland's capital market efficiency up to 2017 generally remained at higher levels compared to Iran, a downward trend in Poland's market efficiency has been observed since 2017. By 2020, this decline resulted in a significant divergence from Iran's market performance. Key economic and political events in Poland during the analysis period include: Accession to the European Union in 2004, Withdrawal of combat troops from Iraq in 2005, and the dismissal of the Prime Minister (the brother of the then-president) in 2007. Regarding Turkey's capital market, as depicted in Figure 3, the efficiency trend has been generally declining since 2001, with a notably sharp downward trajectory beginning in 2012. This trend culminated in 2020, when the gap between Turkey's and Iran's market efficiency reached its widest point. In 2002, the Justice and Development Party (AKP) came to power, leading to a period of relative political stability. The enactment of the Foreign Direct Investment (FDI) Law in 2003, followed by major economic and investment infrastructure reforms, contributed to notable economic growth in the subsequent years.

4.3. Comparative Analysis of Capital Market Efficiency Across Countries

To compare the factors influencing the capital market efficiency of Iran and other countries, mean comparison tests are initially employed. Depending on the normality of the variables, the appropriate statistical test, parametric or non-parametric, is selected. According to the Kolmogorov–Smirnov test results for the study variables, as presented in Table 4, the data do not follow a normal distribution. Therefore, non-parametric tests, specifically the Mann–Whitney U test and the Kruskal–Wallis test, are used for the comparative analysis.

Table 4. Kolmogorov-Smirnov test results

Variable	Iran		Turkey		Russia		Poland	
	Number of statistics	Sig.	Number of statistics	Sig.	Number of statistics	Sig.	Number of statistics	Sig.
SMC	.416	.000	.144	.142	.321	.000	.114	.200
SMCB	.350	.000	.145	.140	.321	.000	.198	.010
SMTR	.128	.200	.172	.034	.311	.000	.185	.022
NC	.199	.006	.231	.001	.149	.115	.229	.001
SMVT	.444	.000	.209	.003	.290	.000	.084	.200
SMR	.160	.063	.171	.034	.208	.003	.128	.200
SMC10	.262	.000	.165	.050	.393	.000	.207	.006
SMVCT10	.236	.000	.118	.200	.378	.000	.252	.000
EF	.162	.057	.225	.001	.211	.003	.183	.025

Table 5 shows the results of the Mann-Whitney test comparing the efficiency of the Iranian stock exchange with that of other countries, taking into account the factors studied. There are statistically significant differences among Iran, Russia, Poland, and Turkey in several capital market indicators, including (Table 5): SMC, SMCB, SMTR, SMVT, SMC10, and SMVCT10. The

Mann–Whitney U test results indicate that the p-values for these variables are all below the 0.05 significance level, confirming statistically significant differences. According to the results: The SMC, SMCB, SMTR, and SMVT are higher in Russia, Poland, and Turkey compared to Iran. However, the SMC10 in Iran exceeds that of Russia, Poland, and Turkey, and the SMVCT10 in Iran is greater than in Russia and Poland.

Table 5. Mann-Whitney test results

	SMC		SMCB		SMTR		NC		SMVT		SMR		SMC10		SMVCT10		EF	
	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic	Group means	Mann-Whitney Statistic
Iran	18.57	114	15.5	28	15.25	21	05.32	292.5	16.14	46	32.29	286	41.5	28	40.79	48	24.82	289
Russia	38.43		41.5		41.75		95.24		40.86		24.71		15.5		16.21		32.18	
Iran	23.43	250	23.43	252	16.14	46	25.45	306.5	18.7	117.5	32.89	213	32.89	31	32.89	148	25.14	298
Poland	31.88		31.88		39.73		29.71		36.98		21.69		21.69		21.69		30.04	
Iran	22.89	235	22.89	214	14.5	269	32.89	279	15.71	34	28.43	390	34.75	217	29.5	364	23.95	183
Turkey	34.11		34.11		42.5		24.11		41.29		28.57		22.25		27.5		21.05	

The Kruskal–Wallis test is employed to examine whether there are statistically significant differences in the research variables across all countries in the sample. Table 6 presents the results of the Kruskal–Wallis test for comparing all variables at the country level. Since the p-value for each variable is 0.0000, which is well below the 0.05 significance level, it can be concluded with 95% confidence that there are statistically significant differences in the variables affecting capital market efficiency across countries. Furthermore, at the 5% significance level, there is a significant difference in the SMR between Iran and Poland, with Iran exhibiting a higher return. In addition, in terms of the efficiency variable (EF), the analysis shows a significant difference between Iran and Turkey at the 5% level, where Iran's market is more efficient, and a significant difference between Iran and Russia at the 10% level, where Russia's market is more efficient.

Table 6. Kruskal-Wallis test results for comparison of efficiency between countries

Country	N	SMC	SMCB	SMTR	NC	SMVT	SMR	SMC10	SMVCT10	EF
Iran	28	134.88	126.57	62.38	277.54	86.57	317.79	372.32	355.14	264.13
Russia	٢٨	277.34	367.96	190.73	202.96	257.71	269.73	156.04	99.36	305.00
Poland	٢٦	167.71	174.15	189.73	280.87	163.48	206.19	204.48	281.96	298.65
Turkey	28	165.05	202.46	414.50	251.91	325.09	٣١٨,٤١	339.43	٣٦٩,٣٩	١٦٩,٤٥
Kruskal-Wallis		230.1*	269.9*	220.2*	397.9*	203.2*	206.19	408.6*	369.3*	141.8*
Deg.		12	12	12	12	12	12	12	12	12

* Significance at the 5% error level

As shown in Table 6, the highest SMC belongs to Russia, with an average rank of 277.34, while Iran has the lowest, with an average rank of 134.88. The highest SMCB is also recorded for Russia with an average rank of 367.96, whereas the lowest is for Iran at 126.57. The highest SMTR is observed in Turkey, with an average rank of 414.50, and the lowest is in Iran, at 62.38. Additionally, the highest NC is found in Poland with an average rank of 280.87, while Russia has the lowest, at 202.96. In terms of SMVT, Turkey ranks the highest with 325.09, and Iran the lowest at 86.57. The highest annual SMR also belongs to Turkey, with an average rank of 318.41, while Poland ranks the lowest at 206.19. Interestingly, Iran holds the highest SMC10 with an average

rank of 372.32, whereas Russia ranks the lowest at 156.04. For the SMVCT10, Turkey leads with 369.39, and Russia ranks the lowest at 99.36. Finally, the highest EF is attributed to Russia with an average rank of 305.00, while the lowest efficiency is recorded for Turkey at 169.45. Moreover, the results of the non-parametric Mann–Whitney U and Kruskal–Wallis tests are consistent with the DEA-based efficiency ranking, confirming the robustness of the findings.

In the following section, for a comparative analysis of the factors influencing stock market efficiency in Iran and selected countries, the market efficiency previously calculated in the prior section is considered the dependent variable. Then, using the variables extracted through multiple regression analysis and by comparing the coefficients, a comparative assessment of the key determinants affecting market efficiency in Iran and other countries is conducted.

$$EF_t = \beta_0 + \beta_1 \mathrm{SMC}_t + \beta_2 \mathrm{SMCB}_t + \beta_3 \mathrm{SMTR}_t + \beta_4 \mathrm{NC}_t + \beta_5 \mathrm{SMVT}_t + \beta_6 \mathrm{SMR}_t + \beta_7 \mathrm{SMC10}_t + \beta_8 \mathrm{SMVCT10}_t + \varepsilon_t \quad (1)$$

In other words, the regression model (1) is estimated separately for each country using their respective data, and subsequently, the following formula is used to compare the coefficients across countries.

$$Z = \frac{\beta_A - \beta_B}{\sqrt{(SE\beta_A)^2 + (SE\beta_B)^2}} \quad (2)$$

In the above equation, βA represents the coefficient of the independent variable in Country A, and βB is the corresponding coefficient in Country B. SE(βA) denotes the standard error of the coefficient for the independent variable in Country A, while SE(βB) is the standard error of the corresponding coefficient in Country B.

Table 7 presents the estimated regression models along with the results of the statistical tests assessing the significance of coefficient differences between Iran and the selected countries. It is worth noting that the Z-statistic indicates whether the differences in coefficients between each country and Iran are statistically significant.

Table 7. The regression test and the difference in the effect of the influencing factors' coefficients on the efficiency of the Iranian stock market and the sample countries.

	Iran				Statistics (Z)
	Coefficients	Standard Error	Significance Level	VIF	
(Constant)	1.1295	0.2267	0.0001		
SMC	0.0017	0.0005	0.0016	2.185	
SMTR	-0.0245	0.0052	0.0001	1.885	
NC	-0.0011	0.0005	0.0325	1.352	
SMR	0.0014	0.0007	0.0413	1.602	
SMC10	0.0006	0.0039	0.8798	1.788	
SMVCT10	0.0021	0.0034	0.5504	2.012	
Fisher's F-statistic		11.487			
Significance level		0.0000			
Durbin-Watson		1.582			
Durbin-Watson statistic after correction		-			
Coefficient of determination		0.766			
Kolmogorov-Smirnov test		0.103			
Significance level		0.2000			
		Russia			Statistics (Z)
(Constant)	0.4901	0.6358	0.4497		
SMC	0.0050	0.004	0.2892	1.194	-0.7266
SMTR	-0.0101	0.003	0.0194	1.380	-2.18822

NC	0.0000	0.000	0.7402	1.362	-2.15261
SMR	0.0035	0.001	0.0204	1.096	-1.37639
SMC10	0.0113	0.016	0.5031	1.076	-0.62938
SMVCT10	-0.0014	0.001	0.4450	1.161	0.90721
Fisher's F-statistic		2.448			
Significance level		0.0612			
Durbin-Watson		1.36			
Durbin-Watson statistic after correction		1.836			
Coefficient of determination		0.424			
Kolmogorov-Smirnov test		0.160			
Significance level		0.066			
		Poland			آماره (Z)
(Constant)	1.0194	0.2773	0.0012		Statistics (Z)
SMC	0.0074	0.0035	0.0439	1.793	-1.6374
SMTR	-0.0053	0.0022	0.0245	1.179	-3.3854
NC	-0.0002	0.0002	0.3040	2.145	-1.8221
SMR	0.0027	0.0012	0.0317	1.305	-0.9203
SMC10	0.0029	0.0054	0.6002	1.353	-0.3422
SMVCT10	-0.0074	0.0035	0.0439	1.267	1.9392
Fisher's F-statistic		4.267			
Significance level		0.005			
Durbin-Watson		1.566			
Durbin-Watson statistic after correction		-			
Coefficient of determination		0.516			
Kolmogorov-Smirnov test		0.091			
Significance level		0.200			
		Turkey			Statistics (Z)
(Constant)	0.53544	0.25780	0.05027		
SMC	0.00435	0.00371	0.25382	2.156	-0.7222
SMTR	-0.0021	0.00051	0.00031	2.232	-4.2468
NC	0.00012	0.00051	0.80948	2.163	-1.7297
SMR	0.00171	0.00048	0.00174	1.485	-0.3409
SMC10	-0.0011	0.00443	0.79534	1.454	0.2985
SMVCT10	0.00128	0.00462	0.78394	2.094	0.1404
Fisher's F-statistic		14.892			
Significance level		0.000			
Durbin-Watson		2.032			
Durbin-Watson statistic after correction		-			
Coefficient of determination		0.810			
Kolmogorov-Smirnov test		0.1161			
Significance level		0.2000			

As shown in Table 7, based on the Fisher (F) statistic, all estimated regression models are statistically significant at the 5% significance level. The values of the Durbin-Watson statistic for all estimated models fall within the acceptable range of 1.5 to 2.5, indicating no evidence of autocorrelation and confirming the independence of regression residuals. In models where the initial Durbin-Watson statistic fell outside the standard range, the Prais-Winsten method was

employed to correct for autocorrelation. Following this adjustment, the Durbin-Watson statistics were brought within the acceptable range, thereby confirming the independence of residuals post-correction. Furthermore, the significance levels obtained from the Kolmogorov-Smirnov test for the regression residuals in all estimated models are greater than 0.05, indicating that the residuals follow a normal distribution. The Variance Inflation Factor (VIF) values for all independent variables across the models are below 10, suggesting that multicollinearity is not a concern. The coefficient of determination (R^2) in each model indicates the extent to which the independent variables explain the variations in market efficiency. The Z-statistic in each model reflects whether the effect of independent variables on market efficiency differs significantly across countries Iran, Russia, Poland, and Turkey. As shown, at the 5% significance level, there are statistically significant differences in the impact of the SMTR variable between the capital markets of Russia, Poland, and Turkey compared to Iran. Additionally, significant differences are observed for the NC variable in the Russian market and for the SMVCT10 variable in the Polish market compared to the Iranian capital market. Table 7 presents the regression results for each country. Several key comparative insights emerge immediately. First, the overall explanatory power of the models varies substantially, with Turkey's model showing the highest fit (F-statistic=14.89) and Russia's the lowest (F-statistic=2.45, insignificant at the 5% level). This suggests that standard financial variables exhibit stronger explanatory power in Turkey's relatively open and financialized market (Akçay & Güngen, 2022), whereas efficiency dynamics in Russia appear less closely aligned with conventional financial indicators, consistent with the greater role of political and strategic considerations emphasized in the literature (Guriev & Treisman, 2019). Second, the direction and significance of key coefficients differ markedly. For instance, the SMTR has a significant positive effect in Poland but a significant negative one in Iran. Similarly, the NC exhibits a significant negative association with efficiency in Iran—a counterintuitive pattern that may reflect structural frictions related to unbalanced market expansion (Lim & Kim, 2011)—while it shows no significant effect in Russia or Turkey. These prima facie disparities underscore that the relationship between common financial indicators and market efficiency is not universal but is critically mediated by each country's distinct institutional and economic context (Salehabadi & Moshiri, 2018). A deeper institutional interpretation of these differences follows in the Discussion section.

5. Discussion and Conclusions

The capital market plays a crucial role in mobilizing domestic resources and channelling them efficiently to enhance production and economic productivity. Therefore, the level of capital market development is a key determinant of a country's savings rate, investment efficiency, and ultimately, its economic growth rate. Given this importance, assessing the position and performance of the capital market, particularly in developing countries, through various indicators, and comparing it with countries that share economic similarities (e.g., reliance on national resources, or experience with economic growth or recession within leading global economies), becomes essential. Identifying the key factors influencing market efficiency is vital for formulating strategies to advance the development of Iran's capital market. To this end, the present study conducts a comparative analysis of the factors influencing capital market efficiency in Iran, Russia, Turkey, and Poland over the period 1975 to 2020. The findings indicate that, based on efficiency scores calculated using the DEA method and comparisons made through the Mann–Whitney and Kruskal–Wallis tests, Iran's capital market ranks below Russia and Poland but above Turkey overall. Furthermore, while the intensity of the impact of certain variables on market efficiency in

Iran differs significantly from those in the other countries, Iran ranks fourth in indicators such as SMC, SMCB, SMTR, and SMVT. However, in terms of the SMC10, Iran ranks first. Additionally, Iran's capital market outperforms Poland and Russia in terms of SMR and the SMVCT10, and surpasses Russia and Turkey in terms of the NC. These results can be attributed to the decline in oil revenues, particularly since 2016, due to the emergence of shale oil and the U.S. withdrawal from the JCPOA in 2018, which led to a contraction in GDP on one hand, and a speculative boom in the stock market during 2019 and 2020 on the other. Listed companies can only rely on capital market financing if stock returns exceed those of alternative investment markets. Therefore, the Iranian capital market, heavily influenced by government interventions, tends to exhibit abnormal behavior in the absence of fundamental economic drivers. This is consistent with the findings of Saadatniya et al. (2024), which indicate that, in comparison with Western European countries, the efficiency of Iran's capital market ranks after the United Kingdom, Spain, Italy, and Greece. Furthermore, indicators such as SMC, SMTR, SMCB, and SMVT are substantially higher in Western European countries than in Iran's stock exchange. The elevated levels of these variables can be attributed to the low inflation rate (minimal inflationary fluctuations) in Western European countries and the increased overall supply of securities (such as an NC and the SMVT), which in turn has led to higher SMCB. Moreover, the results reveal that Iran ranks last in terms of SMTR and SMVT. This can be explained by the underdeveloped nature of the Tehran Stock Exchange and its relatively small share of Iran's overall economy. Nevertheless, the findings show that the SMR in Iran's market ranks highest compared to Western European markets, a phenomenon driven by declining oil revenues, speculative bubbles in the stock exchange, and government interventions. Although the SMC10 in Iran ranks first when compared to Eastern European countries, in comparison with Western European countries, Iran places third behind the United Kingdom and Germany. In terms of efficiency dynamics, considering the studied factors, it appears that fluctuations in Iran's capital market are primarily influenced by domestic-specific elements such as economic sanctions. Due to restrictions on international trade and limited integration with global financial markets, the Iranian capital market remained largely unaffected by global crises such as the 2007–2008 financial crisis and the COVID-19 pandemic in 2020, maintaining its pre-existing trend throughout the study period. Moreover, given the particular economic conditions of Iran, foreign investment in listed companies has remained minimal, and Iranian firms' participation in foreign stock exchanges is also negligible due to severe exchange and transaction constraints. As a result, during the observed period, Iran's capital market has functioned as a largely closed system. This underscores the market's isolation or atomization from global capital markets in terms of efficiency indicators. For instance, during global downturns or financial crises, when capital typically exits stock markets, Iran's efficiency metrics show limited sensitivity due to the minor role of foreign investment. The macroeconomic impact of the aforementioned issue remains manageable as long as Iran's oil-dependent economy is not significantly affected by a decline in its share of global oil sales. However, in recent years (after the reviewed period), following a substantial reduction in Iran's share of the global oil market, this has become increasingly problematic.

5.1. Institutional and Political Economy Interpretation of Cross-Country Differences

The F-statistic values in Table 7 provide initial evidence of fundamental institutional differences. The model for Turkey exhibits the highest F-statistic (14.892), indicating strong explanatory power of standard financial variables in a relatively open economy undergoing a process of financialization, despite its dependent nature and associated vulnerabilities (Akçay & Güngen, 2022). In contrast, the insignificant F-statistic for Russia (2.448) is consistent with the prominence

of state-centric economic governance and episodic geopolitical shocks, which may introduce omitted influences not fully captured by standard financial variables (Guriev & Treisman, 2019). For Poland, the model's weaker significance reflects the growing influence of external EU-level factors and sophisticated qualitative institutional variables post-accession, which are not captured in our quantitative specification (Bojar et al., 2023). Iran's significant but comparatively lower F-statistic (11.487) is consistent with the presence of structural sanctions and episodic political interventions, which may introduce omitted influences and weaken the predictive power of standard financial models (Salehabadi & Moshiri, 2018). The paradoxical negative coefficient of the SMTR in Iran reflects the dual role of liquidity in a sanctioned, speculation-prone market. While liquidity improves operational efficiency, high turnover driven by retail investors can foster price bubbles and undermine short-term operational efficiency—a phenomenon documented in other emerging markets with low openness (Lim & Kim, 2011). In Turkey, the positive but insignificant coefficient implies that turnover acts as a normal market precondition without a deterministic link to efficiency swings. Conversely, the positive and significant SMTR in Poland signifies a healthy, institutionalized market dynamic where enhanced liquidity reduces transaction costs and attracts stable capital. The significant negative coefficient of the NC in Iran highlights a critical warning about unbalanced market expansion. Rapid growth in listings, often through state-led privatization, without concurrent improvements in broader institutional quality discussed in the related literature, can lead to capital dispersion and a dilution of average market efficiency (Lim & Kim, 2011). The statistical insignificance of this variable in Russia further underscores the predominance of macro-political factors over such fundamental financial metrics. Finally, the smaller positive coefficient of SMR in Iran, compared to Turkey, underscores the dampening effect of distortive interventions, such as government-mandated pricing in large listed firms. In contrast, Turkey's stronger positive relationship depicts a more responsive market, where market conditions appear more responsive to observable performance signals within the operational efficiency framework.

5.2. Comparative Analysis of Country-Specific Drivers and Shocks

As for Russia, the sharp decline in economic performance in 2020 appears to have been primarily caused by two major factors: A global downturn in the production and demand for goods and services due to the COVID-19 pandemic (2019–2020) (World Bank, 2020); and A significant drop in oil prices following a failure in negotiations between OPEC and Russia regarding coordinated crude oil production cuts (Reuters, 2020). The Moscow Stock Exchange experienced an approximately 10% decline as oil prices plummeted (Reuters, 2020). Additionally, the ongoing conflict between Russia and Ukraine, beginning in 2014 following the Ukrainian revolution and the annexation of Crimea, has had profound consequences extending far beyond geopolitical boundaries. Russia's sharp efficiency decline in 2020 and the relative stability of Iran's market during global crises are consistent with Memon et al.'s (2024) findings on crisis-driven efficiency dynamics in emerging and G20 markets. Geopolitical shocks and pandemics disproportionately impair markets with higher global integration (e.g., Russia), whereas Iran's structural isolation appears to have mitigated volatility spillovers, narrowing efficiency gaps over time. On one hand, it has affected stock market price efficiency, driven by a combination of factors such as geopolitical uncertainty, macroeconomic instability, and investor sentiment. Generally, in the aftermath of geopolitical conflicts or severe economic shocks (such as the 2007–2008 global financial crisis or the COVID-19 crisis), market participants often face heightened uncertainty regarding future developments, including potential economic sanctions, disruptions in trade, or military escalation. Therefore, uncertainty can lead to increased volatility and reduced liquidity in stock markets.

Investor sentiment, influenced by ongoing conflicts, may also impair stock market efficiency. For instance, negative sentiment resulting from geopolitical tensions can trigger capital flight from the affected region. Consequently, equity prices may deviate from their intrinsic values, making efficient capital allocation more challenging for financial markets. Moreover, the Russia–Ukraine war, due to the interconnectedness of financial markets, has had a potentially far-reaching impact beyond the region itself. In summary, in today's interconnected and globalized world, geopolitical events have profound effects on global financial markets, with consequences often extending beyond the borders of the directly involved countries.

Geopolitical developments ranging from armed conflicts and trade disputes to natural disasters and pandemics carry significant potential to affect financial markets, often triggering sharp market reactions. Russia's economy appears to have been severely affected in 2020, particularly due to the economic repercussions of the war (largely driven by broad economic sanctions) and the COVID-19 pandemic. In terms of market impact, the first factor (sanctions) shows notable similarities with the case of Iran's capital market.

The capital market efficiency in Poland, considering the factors under study, experienced an upward trend in 2000–2001, followed by a significant downturn during the 2007–2008 global financial crisis. Subsequently, the market recovered in 2009, but, like other EU countries, it suffered a sharp decline in 2020 due to the COVID-19 pandemic. These fluctuations in Poland's capital market appear to be largely influenced by global macroeconomic crises, stemming from the country's growing integration with the capital markets of developed economies. Poland joined the European Union in 2004 and, in 2005, ended its military involvement in the Iraq war by withdrawing its troops as part of a coalition with the United States. In 2007–2008, amidst domestic political turmoil and anti-corruption efforts, the Polish government dismissed a corrupt Prime Minister who was also the brother of the then-President, further reinforcing market integrity. Overall, until the global outbreak of COVID-19, Poland generally moved in a direction of capital market growth and improved efficiency. In comparison, based on the methodology used in this study, Turkey's capital market exhibited a consistent decline in efficiency from 2012 to 2020. This trend appears to be heavily influenced by geopolitical tensions, the depreciation of the Turkish lira against the US dollar, and the significant economic shock from the COVID-19 pandemic in 2020. Given Turkey's heavy reliance on tourism revenue, the pandemic had an outsized impact on the country's financial stability.

The observed efficiency advantages of Russia over Iran, despite shared features of state-private hybrid models, align with Petry et al.'s (2023) analysis of state capitalism in emerging market exchanges. In such contexts, securities markets often prioritize government strategic objectives (e.g., control over energy sectors), which can enhance operational scale in resource-rich economies like Russia while constraining liquidity and turnover in more sanctioned environments like Iran.

To further strengthen the theoretical contribution of the present study, the findings are explicitly linked to recent comparative efficiency research. In particular, the relative efficiency patterns observed across Iran, Russia, Turkey, and Poland resonate with Petry et al. (2023), who emphasize the role of state capitalism in shaping securities exchanges in emerging markets, and with Memon et al. (2024), who highlight crisis-driven impacts on market efficiency during geopolitical shocks and pandemics. By integrating DEA-based operational efficiency metrics with these institutional and shock-related frameworks, this study provides a more nuanced understanding of capital market performance in geopolitically constrained and transition economies, bridging productive efficiency measurement with broader theoretical insights on state intervention and external crises.

When interpreting efficiency dynamics over the entire 1975–2020 period, it is essential to consider the treatment of missing data in the early decades, which were handled via mean substitution (as discussed in Section 3). While this method allowed for a balanced panel and facilitated cross-country comparisons, it may reduce observed short-term volatility and smooth structural fluctuations prior to 2000. Therefore, caution is warranted when drawing inferences about the absolute magnitude or oscillations of efficiency in this early period. Nevertheless, the long-term patterns and, critically, the relative efficiency rankings of Iran, Russia, Turkey, and Poland remain robust. Analyses restricted to the post-2000 sub-period, with more complete data coverage, provide the most reliable insights for comparative assessment.

5.3. Conclusions and Policy Recommendations

Based on the above findings, this study makes the following recommendations: First, stock markets should strive to be resilient and adaptable to withstand external shocks. This objective can be achieved through the implementation of a robust regulatory framework. A strong regulatory environment enhances transparency, accountability, investor protection, and ultimately builds investor confidence. Second, capital markets need to leverage technology to improve efficiency, transparency, and accessibility. This includes the adoption of online trading platforms, mobile applications, and other digital services that facilitate easier access for investors. Third, investor education is crucial. Market participants should be provided with the necessary training and knowledge to make informed investment decisions and to better understand market risks and dynamics. Stock exchanges should implement investor education programs to enhance public awareness and understanding of capital markets. These initiatives help investors make more informed decisions and reduce the likelihood of panic selling during periods of external shocks. Fourth, there should be greater diversification of financial instruments. Capital markets must develop and offer a broader range of financial products and services to attract a wider spectrum of investors with varying risk preferences and investment goals. The greater the diversification of financial instruments, the higher the market's capacity to absorb external shocks. Fifth, there should be a strong emphasis on promoting long-term investment. Capital markets should encourage long-term commitments from institutional investors, such as pension funds and insurance companies, as these investors are generally less sensitive to short-term external shocks and contribute to market stability over time. Sixth, promoting regional integration is essential. Regional capital markets such as those in the Persian Gulf or among northern neighbouring countries of Iran hold significant potential for integration, enabling the formation of larger markets with deeper liquidity. Regional consolidation can, in itself, enhance the capacity to absorb individual external shocks. Seventh, to further strengthen capital markets, tax incentives for foreign investors can be introduced. These incentives can help mitigate the impact of external economic fluctuations and reduce economies' over-reliance on foreign investor decisions. Eighth, maintaining a free and open market environment is always recommended. As demonstrated by the experiences of major and emerging economies, stock markets that are heavily influenced by political interventions tend to be more vulnerable to geopolitical decisions. Therefore, capital market development should be driven by the growth potential of listed companies, rather than short-term political considerations.

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References

Agung, D., Ermawati, W. J., & Suprayitno, G. (2023). The impact of the Russia-Ukraine war on the dynamics of the ASEAN-5 stock market. *Eduvest - Journal of Universal Studies*, *3*(12), 2184–2195. https://doi.org/10.59188/eduvest.v3i12.984

Akçay, Ü., & Güngen, A. R. (2022). Dependent financialisation and its crisis: The case of Turkey. Cambridge Journal of Economics, 46(2), 293–316. https://doi.org/10.1093/cje/beac006

Alam, N., Arshad, S., & Rizvi, S. A. R. (2016). Do Islamic stock indices perform better than conventional counterparts? An empirical investigation of sectoral efficiency. *Review of Financial Economics*, *31*, 108–114. https://doi.org/10.1016/j.rfe.2016.06.003

Ali, S., Shahzad, S. J. H., Raza, N., & Al-Yahyaee, K. H. (2018). Stock market efficiency: A comparative analysis of Islamic and conventional stock markets. *Physica A: Statistical Mechanics and its Applications*, *503*, 139–153. https://doi.org/10.1016/j.physa.2018.02.169

Arshad, S., Rizvi, S. A. R., Ghani, G. M., & Duasa, J. (2016). Investigating stock market efficiency: A look at OIC member countries. *Research in International Business and Finance*, *36*, 402–413. https://doi.org/10.1016/j.ribaf.2015.09.026

Basso, A., & Funari, S. (2016). DEA performance assessment of mutual funds. In J. Zhu (Ed.), Data envelopment analysis: A handbook of empirical studies and applications (pp. 283–307). Springer. https://doi.org/10.1007/978-1-4899-7705-0_10

Bekaert, G., Harvey, C. R., & Lundblad, C. (2005). Does financial liberalization spur growth? *Journal of Financial Economics*, *77*(1), 3–55. https://doi.org/10.1016/j.jfineco.2004.05.007

Bojar, A., Howlett, M., & Capano, G. (2023). Policymaking in the EU under crisis conditions: Covid and refugee crises. *Comparative European Politics*, *21*, 722–741. https://doi.org/10.1057/s41295-023-00349-1

Borsch, L. (2018). Influence of fundamental factors and mechanisms on the development of the stock market. *Scientific Bulletin: Finance, Banks, Investments*, *4*, 153–64.

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

Demirgüç-Kunt, A., & Levine, R. (1996). Stock market development and financial intermediaries: Stylized facts. *The World Bank Economic Review*, *10*(2), 291–321. https://doi.org/10.1093/wber/10.2.291

Engle, R. F., & Kroner, K. F. (1995). Multivariate simultaneous generalized ARCH. *Econometric Theory*, *11*(1), 122-150. https://doi.org/10.1017/S0266466600009063

Eurostat. (2022). *Quality report on European statistics on international trade in goods – 2018-2021 data – 2022 edition*. Publications Office of the European Union. https://ec.europa.eu/eurostat/documents/7870049/14743524/KS-FT-22-007-EN-N.pdf

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, *25*(2), 383–417. https://doi.org/10.1111/j.1540-6261.1970.tb00518.x

Guriev, S., & Treisman, D. (2019). Informational autocrats. *Journal of Economic Perspectives*, *33*(4), 100–127. https://doi.org/10.1257/jep.33.4.100

Hammoudeh, S., & Li, H. (2008). Sudden changes in volatility in emerging stock markets: The case of Middle Eastern markets. *International Review of Financial Analysis*, *17*(1), 47–59. https://doi.org/10.1016/j.irfa.2007.02.002

Henry, P. B. (2000). Stock market liberalization, economic reform, and emerging market equity prices. *Journal of Finance*, *55*(2), 529–564. https://doi.org/10.1111/0022-1082.00219

Ikeda, T. (2018). Multifractal structures for the Russian stock market. *Physica A: Statistical Mechanics and its Applications*, *492*, 2123–2128. https://doi.org/10.1016/j.physa.2017.11.129

Khatami, S. M. R., Zomorodian, G. R., Fallah Shams Layalestani, M. F., & Minouei, M. (2023). Examining the interdependence structure of Iran's stock market and MENA countries. *Financial Economics*, *16*(61), 273-310. (In Persian). https://doi.org/10.30495/fed.2023.698852

Kovalevich, D. V. (2018). Prospects of a single financial market development of the EAEU countries. *Nauka i Biznes: Puti Razvitiya*, *8*, 95–99.

Lim, K.-P., & Kim, J. H. (2011). Trade openness and the informational efficiency of emerging stock markets. *Economic Modelling*, *28*(5), 2228–2238. https://doi.org/10.1016/j.econmod.2011.06.008

Lim, S., Oh, K. W., & Zhu, J. (2014). Use of DEA cross-efficiency evaluation in portfolio selection: An application to Korean stock market. *European Journal of Operational Research*, *236*(1), 361–368. https://doi.org/10.1016/j.ejor.2013.12.002

Little, R. J. A., & Rubin, D. B. (2002). *Statistical analysis with missing data* (2nd ed.). Wiley.

Mahmood Robati, M., Barzegar, K., & Ashraf Nazari, A. (2023). A comparative study of the impact of capital market components on economic growth in Iran and selected countries. *Economic Strategy*, *12*(45), 313-350. https://doi.org/10.22034/es.2024.414684.1704 (In Persian).

Memon, B. A., Aslam, F., Naveed, H. M., Ferreira, P., & Ganiev, O. (2024). Influence of the Russia–Ukraine War and COVID-19 Pandemic on the Efficiency and Herding Behavior of Stock Markets: Evidence from G20 Nations. *Economies*, *12*(5), 106. https://doi.org/10.3390/economies12050106

Memon, B. A., Yao, H., & Naveed, H. M. (2022). Examining the efficiency and herding behavior of clean energy exchange-traded funds (ETFs) and their benchmarks: Evidence from asymmetric multifractal analysis. *Frontiers in Environmental Science*, *10*, 946015. https://doi.org/10.3389/fenvs.2022.946015

Miloş, L. R., Haţiegan, C., Miloş, M. C., Barna, F. M., & Boţoc, C. (2020). Multifractal detrended fluctuation analysis (MF-DFA) of stock market indexes. Empirical evidence from seven Central and Eastern European markets. *Sustainability*, *12*(2), 535. https://doi.org/10.3390/su12020535

Nasrollahi, Z., Tyebi, R., Fotovat, A., & Eskandaripour, Z. (2018). Transmission of volatility between stock markets of Iran, India, and Turkey using BEKK-GARCH model. *Monetary & Financial Economics*, *25*(16), 77–92. https://doi.org/10.22067/pm.v25i15.28923

Petry, J., Koddenbrock, K., & Nölke, A. (2023). State capitalism and capital markets: Comparing securities exchanges in emerging markets. *Environment and Planning A: Economy and Space*, *55*(1), 143–164. https://doi.org/10.1177/0308518X211047599

Peykani, P., Mohammadi, E., Emrouznejad, A., & Gheidar-Kheljani, J. (2024). A novel robust network data envelopment analysis approach for performance assessment of mutual funds under

uncertainty. *Annals of Operations Research*, *339*(3), 1149–1175. https://doi.org/10.1007/s10479-022-04625-3

Ramazanov, A. V. (2022). Factors affecting the stock market in Russia and the regulation of its development. *Digital Economy & Innovations*, *1*(1), 32–40. https://doi.org/10.18323/2221-5689-2022-1-32-40

Reuters. (2020, March 9). Russian stock market dives as oil price war, coronavirus fears hit. *Reuters*. https://www.reuters.com/article/russia-markets-idUSL8N2B21A3

Saadatniya, M., Tamimi, M., Salehi, A. K., Rekabdar, G. (2024). Comparative Study of the Iran Capital Market and Western European Countries from the Perspective of Efficiency. *Journal of Investment Knowledge*. Advance online publication. https://doi.org/10.30495/jik.2024.77593.4538

Saâdaoui, F. (2023). Skewed multifractal scaling of stock markets during the COVID-19 pandemic. *Chaos, Solitons & Fractals*, *170*, 113372. https://doi.org/10.1016/j.chaos.2023.113372

Salehabadi, A., & Moshiri, S. (2018). The role of institutional factors in the efficiency of the Tehran Stock Exchange. In *Proceedings of the 3rd International Conference on Management, Accounting & Knowledge with an Emphasis on Resistance Economy* (pp. 1–14). Ayandegan Institute of Higher Education.

Saputra, D. C., Hamidi, I., & Syathiri, A. (2023). Comparative analysis of Sharia stock price indices in Indonesia, Turkey, China, and Malaysia: A study of integration in Sharia capital markets. *Journal of Islamic Civilization*, *5*(2), 157–176. https://doi.org/10.33086/jic.v5i2.5407

Smith, G. (2024, April 16). *How do geopolitical shocks affect stock markets? LPL Financial*. https://www.lpl.com/newsroom/read/how-do-geopolitical-shocks-affect-stock-markets.html

Topcu, M., & Gulal, O. S. (2020). The impact of COVID-19 on emerging stock markets. *Finance Research Letters*, *36*, 101691. https://doi.org/10.1016/j.frl.2020.101691

World Bank. (2020). Global economic prospects, June 2020. *World Bank*. https://www.worldbank.org/en/publication/global-economic-prospects

World Federation of Exchanges. (2017). *WFE annual statistics report 2016*. https://www.world-exchanges.org/our-work/statistics

Yartey, C. A. (2008). The determinants of stock market development in emerging economies: Is South Africa different? *IMF Working Paper*, WP/08/32. https://www.imf.org/external/pubs/ft/wp/2008/wp0832.pdf

Yousaf, I., Patel, R., & Yarovaya, L. (2022). The reaction of G20+ stock markets to the Russia–Ukraine conflict "black-swan" event: Evidence from event study approach. *Journal of Behavioral and Experimental Finance*, *35*, 100723. https://doi.org/10.1016/j.jbef.2022.100723

Zaheer, K., Aslam, F., Mohmand, Y. T., & Ferreira, P. (2024). On the dynamic changes in the global stock markets' network during the Russia–Ukraine war. *Economies*, *12*(2), 41. https://doi.org/10.3390/economies12020041