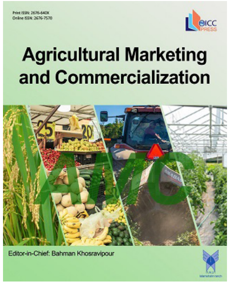

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Original Article

Providing an Adaptive Model for Pricing Option Contracts in Iran'S Capital Market

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Abstract
This research aims to provide an adaptive framework for pricing option contracts in Iran's capital market by comparing several widely recognised option pricing models, including the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree models. These models were selected because they represent the most frequently applied frameworks in both developed and emerging markets, with the Heston and Bi-Heston models incorporating stochastic volatility features that make them suitable for economies experiencing inflation and market instability, such as Iran. The need for this comparative analysis stems from the increasing volume of option trading and the inadequacy of the currently used Black–Scholes model in reflecting Iran's economic and inflationary conditions. The proposed adaptive approach, presented in the Methodology section, tests these models on data from the Tehran Stock Exchange (2018–2023) and evaluates their performance using RMSE and MAPE error metrics to identify the model that produces the most accurate price estimates. Data related to selected call option symbols (Shesta, Khodro, Khsapa, and Ahrom), filtered based on the highest trading volume and value, were analyzed using Python software and its NumPy and Pandas libraries. Based on the results obtained from the data analysis of the selected symbols, the Trinomial Tree model and the Badestein model showed significantly less error compared to the Black-Scholes model in estimating the market price of option contracts. The research findings indicate the significant superiority of the Trinomial Tree and Badestein models over the commonly used Black-Scholes model in Iran's capital market. Employing these more accurate models can lead to more efficient pricing of option contracts and reduce the gap between theoretical value and market price.

Keywords: Option Contracts, Pricing Model, Black-Scholes Model, Badestein Model, Trinomial Tree.

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INTRODUCTION

In recent years, derivatives have gained a prominent position as key financial instruments in capital markets and financial institutions. These instruments not only enable investors to manage risk more effectively but also create opportunities for higher returns and greater market efficiency(Peymany Foroushani, 2024). Among the various types of derivatives, option contracts stand out as some of the most widely used and attractive. A sound understanding of these contracts—particularly their pricing methods—is vital for both investors and financial analysts, since accurate valuation plays a decisive role in making informed decisions, improving risk management, and taking advantage of profitable opportunities in the market (Seifi, 2023).

An option contract grants its holder the right, but not the obligation, to buy or sell an underlying asset at a predetermined price (known as the strike or exercise price) within a specified period. At the beginning of the contract, the holder pays a premium, and their net payoff at maturity equals the return from the contract minus this premium. Consequently, the accurate determination of the option premium is considered one of the central issues in finance and investment(Black, 1973).

One of the most influential and widely applied models for option pricing at the international level is the Black–Scholes model, developed by Black and Scholes in 1973 (Farahani, 2024). This model is based on assumptions such as constant volatility, geometric Brownian motion in the price of the underlying asset, and a lognormal distribution of stock prices. While the Black–Scholes model marked a turning point in the field of derivative valuation, it faces important practical limitations (Hassani, 2024). The main criticism concerns its assumption of constant volatility and normally distributed returns—conditions that rarely hold in real markets, especially in emerging and inflation-prone economies such as Iran (Rahayu, 2025).

In Iran, option trading was introduced on the Tehran Stock Exchange in 2018, with the Black–Scholes model adopted as the primary valuation method. Nevertheless, due to its age, oversimplified assumptions, and lack of alignment with the specific features of the Iranian market—including high inflation, time-varying volatility, and non-normal price behavior—this model requires revision.

This study therefore seeks to address the shortcomings of the Black–Scholes framework by evaluating and comparing its performance and efficiency with alternative pricing models applied in the stock exchanges of both developed and emerging markets, such as Turkey, China, the United States, and Malaysia. In particular, it examines the Heston model, which incorporates stochastic volatility and corrects for some of the weaknesses of the Black–Scholes approach. The ultimate objective is to identify and recommend a pricing model that is not only efficient but also better suited to Iran's economic and inflationary conditions, producing the smallest possible gap between theoretical values and actual option prices in the market.

METHODOLOGY

Population of the Study

This research focuses on all call option contracts traded on the Tehran Stock Exchange from 2018 (1397) through the end of 2023 (1402).

Sampling Method and Sample Size

The study includes all option contracts listed on the Tehran Stock Exchange, provided that they have sufficient trading volume to allow for statistical testing. An additional screening process was then applied: each contract had to have a minimum of 51 trading days within its trading period, and the ratio of days with trading activity to the total trading days had to be at least 0.7. After applying these criteria, the contracts with the highest trading volumes—namely *Shasta, Khodro, Khesapa,* and *Ahram*—were selected as the representative sample.

Data Analysis Methods and Tools

The main objective of this research is to compare the most well-known and widely applied option pricing models used in developed markets and in economies with conditions similar to Iran, with those applied in the Iranian capital market, in order to identify the most appropriate model (i.e., the one with the lowest pricing error).

To conduct the analysis, the theoretical option price (P_e) was first calculated using the assumptions of each selected model and then compared with the actual market price (closing price, P). Model performance was evaluated using two error measures: The Root Mean Squared Error (RMSE) and the Mean Absolute Percentage Error (MAPE). The model that produced the smallest error values was considered the most suitable under Iran's economic and market conditions.

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(P-P_e\right)^2}$$

MAPE=1001n∑t=1n|At−FtAt|

$$MAPE= \frac{1}{n}\sum_{1}^{n}\frac{\frac{|F-A|}{A}}{n}$$

In this formula, A_t represents the actual value and F_t denotes the forecasted value. The difference between the two is divided by the actual value. The absolute value of this ratio is then calculated for each forecast, summarized over time, and finally divided by the number of observations (n).

The Mean Absolute Percentage Error (MAPE) is a statistical measure used to evaluate the accuracy of a forecasting method. It expresses accuracy as a percentage, based on the formula described above.

Description of the Applied Models

1. The Black–Scholes Model

The Black–Scholes model is one of the most fundamental and widely recognised methods for option pricing. It revolutionised financial theory by providing, for the first time, a closed-form analytical solution for valuing option contracts. Developed in 1979 by Fischer Black, Myron Scholes, and Robert Merton, the model remains one of the most extensively applied approaches in both academic and practical contexts(Wu, 2019).

This model is based on five key input parameters: the stock price (S), the strike price (K), the time to maturity (T), the risk-free interest rate (R), the standard normal cumulative distribution function (N(d)), and the implied volatility (σ) of logarithmic stock returns. Because of its simplicity and analytical clarity, the Black–Scholes formula has become a common language among option traders and serves as a benchmark for determining the fair value of options in global financial markets.

The formulae are given as follows:

10.57647/amc.2026.100110

$$C = S_0\, N(d1) - ke^{-rt} N(d2)$$

$$p = ke^{-rt} N(-d2) - S_0 N(-d1)$$

Assumptions of the Black–Scholes Model:

· Random Walk: Stock prices follow a stochastic process and cannot be predicted deterministically.

· Constant Volatility: Volatility, representing the expected magnitude of price fluctuations, is assumed to be constant and known.

· Normally Distributed Returns: The returns on the underlying asset are normally distributed, implying that future stock prices follow a log-normal distribution. However, in real markets, empirical return distributions often exhibit skewness and kurtosis, which may cause pricing biases.

· No Dividends: The model assumes that the underlying asset does not pay dividends or other distributions during the option's life. In reality, dividend payments reduce stock prices and thus affect call and put option values.

2. The Heston Model

To address the limitations of the Black–Scholes framework, the Heston model was developed in 1993. It introduces stochastic volatility by allowing the variance of the asset return to follow its own random process. Under this model, asset return distributions exhibit asymmetry, fat tails, and volatility smiles, which are frequently observed in real markets.

Let the underlying asset price be StS_tSt, the instantaneous variance VtV_tVt, the risk-free rate rrr, and ρ\rhoρ the correlation between the two Brownian motions. Under the risk-neutral dynamics, the model is defined as:

$$dS = rSdt \sqrt{V}\, Sdz1$$

$$dV = (a - bV)dt + \sqrt{V}\, dz2$$

Here, aaa represents the mean reversion speed, bbb the long-term variance level, and σ\sigmaσ the volatility of volatility.

3. The Bi-Heston Model

Although the Heston model effectively captures stochastic volatility, some researchers have noted that it may not perfectly reproduce the observed implied volatility smiles. The Bi-Heston model extends the Heston approach by incorporating two stochastic variance processes and allowing for dynamic correlation between them. This extension improves model flexibility and calibration accuracy.

The Bi-Heston model can be represented as follows:

$$dS = rSdt + \sqrt{V1}\, Sdz1 + \sqrt{V2}\, Sdz2 \quad (3)$$

$$dV1 = (a1 - b1V1)dt + \sigma \sqrt{V1}\, dz3 \quad (4)$$

$$dV2 = (a2 - b2V2)dt + \sigma \sqrt{V2}\, dz4$$

This model allows for richer volatility dynamics and is particularly useful for pricing options in markets characterised by high volatility clustering and asymmetric risk profiles.

4. The Binomial Tree Model

The binomial tree model, introduced in the late 1970s by John Cox, Stephen Ross, and Mark Rubinstein, provides a discrete-time framework for option valuation. It represents possible future stock price movements as a recombining tree, where at each step the price can move upward or downward by a fixed proportion.

Option values are calculated by backward induction, starting from the terminal nodes (maturity) and discounting expected payoffs to the present using the risk-free rate. The model is computationally simple, intuitive, and consistent with the principle of risk-neutral valuation.

The general pricing formula is:

$$f = e^{-rt} r \left[pf_{u+(1-p)\, fd} \right]$$

where ppp is the risk-neutral probability of an upward move, fuf_ufu and fdf_dfd are the option values at the up and down nodes, respectively.

5. The Trinomial Tree Model

The trinomial tree model, developed by Phelim Boyle in 1986, extends the binomial framework by adding a third possible price movement at each node—up, down, or unchanged. This model provides greater numerical stability and convergence accuracy, especially for options with long maturities or high volatility.

Under this approach, the option price is determined as:

$$f = e^{-rt} \left[p_u f_{u+} p_m\, f_m + p_m\, f_m \right]$$

This model is mathematically equivalent to the explicit finite difference method and is often preferred for its computational efficiency and improved accuracy.

RESULTS

To calculate the forecasting error of the models, the assumptions and estimates presented in (**Table 1**) are considered:

In the Black–Scholes model, the parameter δ is calculated using the daily logarithmic returns of the underlying asset (stock). In other words, the daily log returns are computed based on the stock prices. Furthermore, considering historical trends, real market data, and the assumptions embedded in the software, the parameters presented in (**Table 2**) were estimated.

In (**Table 2**), the comparison of the *Khodro* option (symbol: Z-Khodro) is presented, where the market closing price is analyzed against the theoretical prices obtained from the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree valuation models.

In (**Table 3**), the comparison of the *Ahram* option (symbol:

Table 1. Estimated Data

parameters	values
Initial Volatility	0.25
Long-Term Volatility	0.35
Volatility of Volatility	0.40
Correlation Coefficient	-0.05
Mean Reversion Speed	1.5
Number of Steps	100
Long-Term Process Mean	0.03
Dividend Yield	0
Risk-Free Rate (Annual)	0.25

Table 2. Comparison of Call Option Prices for the *Khodro* Symbol Using the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree Models

Symbol / Price	Strike Price	Underlying Stock Price	Market Closing Price	Black–Scholes	Heston	Bi-Heston	Binomial Tree	Trinomial Tree
ZKHOD 1122	3,000	2,709	54	35	55	50	50.8	48
ZKHOD 1120	2,600	2,617	229	215	245	220	225.3	218
ZKHOD 1121	2,800	2,623	103	98	110	95	95.6	93
ZKHOD 1119	2,400	2,661	401	380	430	390	395.2	388
ZKHOD 1217	2,400	2,940	475	422	510	460	465.9	458
ZKHOD 1220	3,000	2,972	138	74	150	130	130.4	128
ZKHOD 1216	2,200	2,932	660	602	710	650	655.7	648
ZKHOD 1215	2,000	2,718	818	793	880	810	810.5	808
ZKHOD 1219	2,800	2,838	195	150	210	190	185.2	188

Z-Ahram) is presented, where the market closing price is evaluated against the theoretical prices derived from the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree valuation models.

In (**Table 4**), the comparison of the *Khesapa* option (symbol: Z-Sapa) is presented, where the market closing price is assessed against the theoretical prices obtained from the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree valuation models.

In **Table 5**, the comparison of the *Shasta* option (symbol: Z-Sta) is presented, where the market closing price is evaluated against the theoretical prices derived from the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree valuation models.

The calculation of the Root Mean Squared Error (RMSE) is presented in (**Table 6**), followed by the calculation of the Mean Absolute Percentage Error (MAPE) in (**Table 7**). Finally, a comparative evaluation of RMSE and MAPE is provided in (**Table 8**).

Charts Comparing Option Pricing Models

Based on the results obtained and the calculations of RMSE and MAPE for the call option symbols *Shasta*, *Khodro*, *Khesapa*, and *Ahram* in 2023 (1402), the errors of the Trinomial Tree and Bi-Heston models were found to be significantly lower than those of the other models. These two models also showed the smallest discrepancies compared to the actual market prices of options on the Tehran Stock Exchange, as illustrated in (**Figure 1**).

It should be noted that the Heston and Bi-Heston models, which are based on stochastic volatility, require very precise parameter estimation. This process is complex, challenging, and demands a high degree of accuracy to

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Table 3. Comparison of Call Option Prices for the *Ahram* Symbol Using the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree Models

Symbol / Price	Strike Price	Underlying Stock Price	Market Closing Price	Black–Scholes	Heston	Bi-Heston	Binomial Tree	Trinomial Tree
ZHERAM 1224	20,000	20,690	2,978	2,249	3,200	3,090	3,100	3,080
ZHERAM 1225	22,000	21,390	1,952	1,178	2,100	1,990	2,050	1,970
ZHERAM 1219	13,000	21,920	8,600	8,357	8,800	8,640	8,700	8,610
ZHERAM 1222	16,000	22,190	5,811	5,523	5,950	5,840	5,900	5,830
ZHERAM 1223	18,000	22,030	4,259	3,747	4,500	4,290	4,400	4,268
ZHERAM 1226	28,000	21,690	1,245	538	1,500	1,340	1,400	1,310
ZHERAM 1228	24,000	21,300	501	79	700	670	700	675

Table 4. Comparison of Call Option Prices for the *Khesapa* Symbol Using the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree Models

Symbol / Price	Strike Price	Underlying Stock Price	Market Closing Price	Black–Scholes	Heston	Bi-Heston	Binomial Tree	Trinomial Tree
Khesapa 1000	2,200	2,438	215	238	246	210	218	214
Khesapa 1001	2,400	2,596	57	71	70	60	65	60
Khesapa 1012	1,900	2,430	510	535	540	515	539	500
Khesapa 1002	2,600	2,574	19	7	8	20	25	20
Khesapa 1220	2,400	2,538	267	225	230	260	285	265
Khesapa 1219	2,200	2,577	380	361	360	370	335	375
Khesapa 1222	2,800	2,693	95	64	65	100	105	100
Khesapa 12121	2,600	2,592	166	126	130	165	180	170

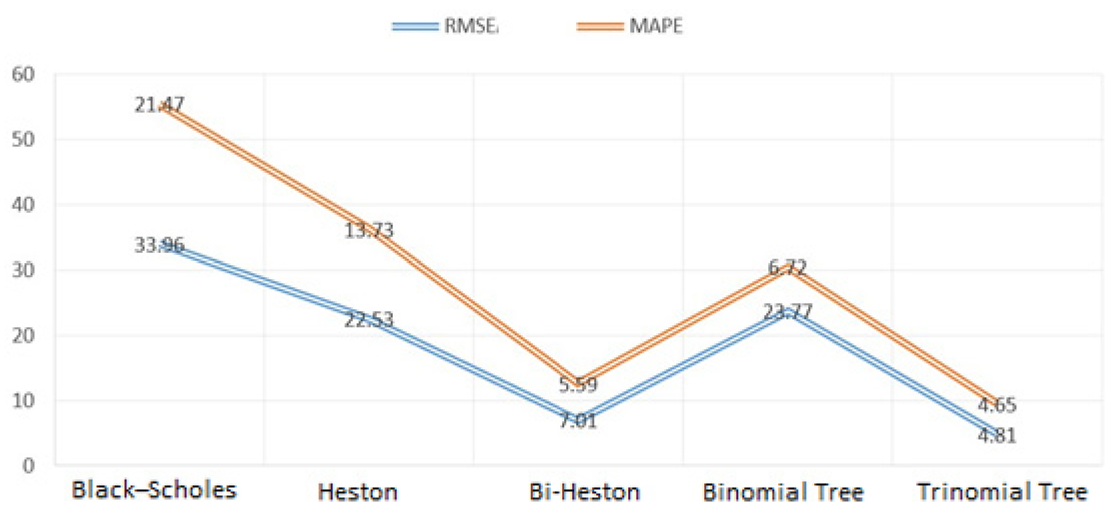

Figure 1. Charts Comparing Option Valuation Models

10.57647/amc.2026.100110

Table 5. Comparison of Call Option Prices for the *Shasta* Symbol Using the Black–Scholes, Heston, Bi-Heston, Binomial Tree, and Trinomial Tree Models

Symbol / Price	Strike Price	Underlying Stock Price	Market Closing Price	Black–Scholes	Heston	Bi-Heston	Binomial Tree	Trinomial Tree
Shasta 1216	1,212	1,246	126	115	118	129	132	128
Shasta 1220	1,612	1,150	20	5	6	8	20	23
Shasta 1214	1,012	1,158	294	276	284	295	305	298
Shasta 1215	1,112	1,144	201	188	182	203	205	202
Shasta 1217	1,312	1,166	70	62	62	68	71	68
Shasta 1212	812	1,096	478	466	473	477	485	475
Shasta 1218	1,412	1,155	40	30	29	37	43	36
Shasta 1209	512	1,086	767	755	778	771	775	769

Table 6. Calculation of Root Mean Squared Error (RMSE)

Option Symbols / Pricing Models Symbol	Black–Scholes	Heston	Bi-Heston	Binomial Tree	Trinomial Tree
ZKHOD	35.39	31.76	9.165	6.85	11.09
ZAHRM	2.56	20.04	8.62	13.41	8.07
ZKHSAPA	79.27	26.87	5.412	21.19	4.74
ZSTA	70.12	11.46	4.84	6.10	2.80
RMSE	96.33	22.53	7.01	23.77	4.8

Table 7. Calculation of Mean Absolute Percentage Error (MAPE)

Option Symbols / Pricing Models Symbol	Black–Scholes	Heston	Bi-Heston	Binomial Tree	Trinomial Tree
ZKHOD	15.98	6.86	3.98	3.35	5.13
ZAHRM	32.13	12.23	6.96	9.61	6.42
ZKHSAPA	22.60	21.32	3.11	11.2	2.83
ZSTA	15.20	14.51	8.31	2.74	4.02
MAPE	21.47	13.73	5.59	6.72	4.6

Table 8. Comparison of RMSE and MAPE

Option Symbol / Pricing Model	Black–Scholes	Heston	Bi-Heston	Binomial Tree	Trinomial Tree
RMSE	33.96	22.53	7.01	23.77	4.8
MAPE	21.47	13.73	5.59	6.72	4.6

achieve reliable results (**Table 9**).

DISCUSSION

This study analyzed the differences between market closing prices of call options and their theoretical values calculated using the Black–Scholes model, the Heston and Bi-Heston models (stochastic volatility models), and the Binomial and Trinomial Tree models for the most actively traded symbols—*Shasta*, *Iran Khodro*, *Khesapa*, and *Ahram*—in 2023.

After calculating the Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE), the Trinomial Tree, Bi-Heston, and Binomial Tree models exhibited significantly lower errors and smaller deviations from actual market prices compared to the other models. Therefore, these models are recommended for valuing options with substantial trading volume and market significance. It should be noted, however, that the Heston

Table 9. Results of Option Valuation Models for Call Options in the Iranian Capital Market

Option Symbols / Pricing Models Symbol	Black–Scholes		Heston		Bi-Heston		Binomial Tree		Trinomial Tree	
	RMSE	MAPE	RMSE	MAPE	RMSE	MAPE	RMSE	MAPE	RMSE	MAPE
ZKHOD	39.35	15.98	31.76	6.86	9.16	3.98	6.85	6.85	11.09	5.13
ZAHRM	56.2	32.13	20.04	12.23	8.62	9.61	13.41	13.41	8.07	6.42
ZKHSAPA	27.79	22.60	26.87	21.32	5.41	11.2	21.19	21.19	4.74	2.83
ZSTA	12.70	15.20	11.46	14.51	4.84	2.74	6.10	6.10	2.80	4.02
RMSE-MAPE Mean	33.96	21.47	22.53	13.73	7.01	5.59	23.77	23.77	4.8	4.6

and Bi-Heston models, being based on stochastic volatility, require highly precise parameter estimation, which is both complex and demanding.

Given the growing significance of derivatives in global financial markets and the increasing use of options—particularly in the emerging Iranian market—this study initially reviewed commonly used option pricing models in developed markets, such as the United States as a developed, advanced, and mature market, and in emerging markets, such as China. The Malaysian and Turkish markets were also considered as a market for Islamic countries with Turkey serving as a representative case of an inflationary economy similar to Iran. The Heston and Bi-Heston models, which extend the Black–Scholes framework to address its limitations, were used to calculate theoretical option prices and compared with actual market data. The results indicated that the Trinomial Tree and Bi-Heston models consistently demonstrated lower errors and closer alignment with market prices in the Iranian capital market. It is also important to note that in the Black–Scholes model, option valuations in Iran often underestimate the true value during the early stages of trading due to prevailing economic conditions(Amini, 2025). Meanwhile, the Bi-Heston model, while theoretically more accurate, is highly sensitive to parameter estimation. If parameters are inaccurately estimated, the advantages of the model may be reduced (Paulin, 2020).

According to the presented calculations, two models, that is, Trinominal tree and Bi-Heston have been examined in most of the option prices (Shasta, Khodro, Khesapa, and Ahram), by the least error in MAPE and RMSE. In other words, there is less difference between the theoretical price of these two models and the end price of the market respective to the models such as Black–Scholes or two nominal. This finding is due to their flexibility to volatility modeling ignoring the simplified assumptions of volatile markets. This is because of their superiority (Sofla, 2025).

The findings of this study are consistent with international research. For example, analyses of Microsoft stock market data demonstrate that stochastic volatility models, such as Heston and Bates, yield lower RMSE values than Black–Scholes and more effectively capture skew and other complexities in market data. A major limitation of the Black–Scholes model is its assumption of constant volatility and normally distributed returns, which rarely holds in real-world markets, particularly in economies experiencing high volatility (Kebriyayee, 2025).

Assuming Bi-Heston model with a stochsatic volatility process tries to cover the shortcomings, while has a high sensitivity to estimate the parameters. As mentioned, accurate estimation of parameters mostly challenges the volatility models if they are not satisfied. The theoretical benefit, therefore, is possible to be reduced(Daneshzad, 2024; Xiang, 2025).

From a practical perspective, selecting a model with minimal prediction error is particularly important in the Iranian market, characterized by high inflation, stock price volatility, market imbalances, and incomplete hedging opportunities. The Trinomial Tree model offers practical advantages due to its simpler structure and effective approximation, performing well in this study. The Bi-Heston model, although more complex, better reflects actual market behavior and is therefore highly suitable for practical applications (Brigo, 2008; Chowdhury, 2020).

International studies have also examined the performance of parametric, non-parametric, and hybrid models. For instance, when parametric models are compared with non-parametrics in option pricing. In certain cases, semi-parametric or combined approaches can provide competitive results. Moreover, model accuracy alone is insufficient; computational complexity, the need for parameter recalibration over time, model stability during market stress, and implementability on trading platforms are equally important. Research on model risk indicates that frequent recalibration of parameters can itself be a source of risk, even when initial theoretical accuracy is improved (Wu, 2019).

CONCLUSION

The results of this study indicate that among the models examined, the Trinomial Tree and Bi-Heston models provided the most accurate estimates of call option prices, exhibiting the lowest prediction errors in terms of RMSE and MAPE compared to actual market prices. This

10.57647/amc.2026.100110

advantage stems from their greater flexibility in capturing real market volatility. In contrast, the Black–Scholes model assumes constant volatility and normally distributed returns, limiting its ability to reflect the complex dynamics of actual financial markets. Advanced models such as Bi-Heston, which incorporate stochastic volatility, better capture real market behavior. This capability is particularly important in the Iranian market, where high price volatility, supply-demand imbalances, and the absence of complete hedging instruments make accurate modeling essential.

Nevertheless, the Bi-Heston model presents practical challenges due to its complexity and the need for precise parameter estimation. The Trinomial Tree model, on the other hand, offers a simpler structure and more flexible parameter adjustments, making it a practical and effective option. While Bi-Heston provides higher theoretical accuracy, the Trinomial Tree model is more suitable for practical use in emerging markets such as Iran due to its relative computational simplicity and stability with real-world data.

Overall, both the Bi-Heston and Trinomial Tree models are highly effective in reducing errors in option pricing and can serve as viable alternatives to traditional models such as Black–Scholes in the Iranian market. The choice between these two models depends on the analyst's objectives: for maximum theoretical accuracy and detailed volatility analysis, the Bi-Heston model is preferred; for rapid and practical implementation with lower computational requirements, the Trinomial Tree model is more appropriate.

RECOMMENDATIONS

Based on the findings of this study and the increasing activity in the Iranian options market, along with the influence of volatility and inflation on option pricing, the following recommendations are proposed:

1. The Securities and Exchange Organization of Iran should, in addition to current valuation methods, allow the use of stochastic models such as Bi-Heston and Heston for pricing the most actively traded options.
2. Future research could explore modified versions of the Black–Scholes model, incorporating implied volatility calculations, to improve accuracy and applicability in the Iranian market.

Author's contribution

Mehrdad Miri and Jalal Seifoddini conceived and designed the study. Reza Nemati Koshteli and Abdollah Rajabi Khanghah were responsible for data acquisition and preliminary data processing. Mehrdad Miri and Nader Naghshineh performed the data analysis, interpreted the results, and drafted the initial version of the manuscript. Jalal Seifoddini provided critical revisions and methodological oversight. All authors contributed to the intellectual content, reviewed and edited the manuscript, and approved the final version for publication.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Conflict of interest

The authors declare that they have no conflict of interests.

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