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Blockchain Technology in Addressing Economic Issues: Opportunities and Challenges in the Share Market Using Mathematical Models

Gapat Parmeshwar Uttreshwar[1,] *, Hakim Burhanoddin Akram[1], Manasi Kurtkoti[2], Yogesh Ingale[3], Satishkumar Mulgi[3]

[1]Department of Mathematics, Dr. D. Y. Patil Arts, Commerce and Science College Pimpri, Pune, Maharashtra, India

[2]Department of Economics, Dr. D. Y. Patil Arts, Commerce and Science College Pimpri, Pune, Maharashtra, India

[3]Department of Computer Science, Dr. D. Y. Patil Arts, Commerce and Science College Pimpri, Pune, Maharashtra, India

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Abstract: In recent times, blockchain technology has emerged as revolutionary technology in various fields, especially in financial and capital markets. The main objective of this research is to analyze the changes in efficiency due to the mathematical concepts of how to improve the performance of the stock market. Three main mathematical models have been used in this study - Market Efficiency Model (Market Efficiancy Model), cost difference models (Cost Differential Model), and risk display models (Risk Exposure Model). These models consider the proportion of transactions, instability, duration of transaction and the relationship between the traditional and blockchain-based system.

To support these theories, realistic projects in India and internationally have been included. In India, the background of the National Stock Exchange Blockchain Sandbox Project, CDSL's registration management, and the Reserve Bank of India has been investigated by the background of bond transactions. It has also studied international activities like Nasdaq Linq, Australian Securities Exchange (ASX) and JP Morgan Onyx International activities like this have been studied. In addition, blockchain limits have also been thoroughly analyzed-for example, scalability problems, energy consumption (especially in proof -of-work systems), errors in smart contracts, legal uncertainty and technical complications in combination with conventional systems. These problems have been considered theoretically (such as quaching theory, energy consumption models, game theory, etc.).

Keywords: Blockchain Technology; Share Market; Scalability; Mathematical Modelling; Market Efficiency; Smart Contracts; Transaction Costs; Settlement Latency; Financial Technology; Risk Management; Decentralized Ledger; Regulatory Challenges; Transparency; Peer-to-Peer Trading; Digital Assets.

I. Introduction:

The stability of the world economy is the based on financial system and share markets. However, traditional share markets have intermediaries, latency, and a lack of transparency, which lead to inefficiencies and increased transaction costs. Blockchain provides a revolutionary alternative because of its decentralized and impenetrable structure. This study examines how blockchain might change stock markets and evaluates its effects using mathematical modelling.

Overview of Blockchain Technology in Finance

Blockchain operates as a distributed ledger secured by consensus mechanisms. In financial contexts, it enables peer-to-peer transactions, real-time settlement, and immutable audit trails. Key features include:

- **Decentralization**
- **Cryptographic Security**
- **Smart Contracts**
- **Tokenization**

Applications in finance include decentralized exchanges (DEXs), blockchain-based clearinghouses, and security token offerings (STOs).

Economic Issues in Share Markets

Latency in Settlement (T+2 Days)

Problem: Easing counterparty risk and capital lock-in in traditional settlement cycles that can take up to 2 business days requires improvement.

Blockchain Solution:

• Smart contracts on blockchain enables pre-condition trades, allowing for instantaneous settling. This is referred to as T+0 settlement.

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• Atomic Settlement guarantees payment within settlement duration eliminating risk of mediators.

Example: Decentralized exchanges are fully testing near-instant or real-time settlements while pilot projects, such as DTCC's Project Ion, are exploring the functionality.

High Intermediary Costs (Clearing Houses, Custodians)

Problem: Gaining several intermediaries results in an increase in transactional fees which reduces profits earned by investors due to increased time requirements.

Solution via Blockchain:

• Eliminating third parties leads to peer-to-peer asset exchange through smart contracts taking over clearing and settlement functions. This is known as Disintermediation.

• Distributed ledger technology enhances automation for reconciliation and minimizes office workload increasing operational efficiency reducing overhead expenses

Example: Australia's Securities Exchange blockchain system implementation replaces CHESS with the goal of lowering costs associated.

Lack of Transparency in Orderbooks

Problem: Opaque order flows limit fairness to participants involve effort that renders unaccountable such concealed orders dark pools masquerade within traditional markets.

Solution via Blockchain:

• Every transaction can be recorded which ensures all actions can be audited encouraging full transparency thus fostering trust including open and immutable ledgers ensuring no alteration records bounded instruction.

Mathematical Modelling of Blockchain-Based Share Market

1. Market Efficiency Model (ME Model):

This model helps to evaluate how the blockchain reduces letters and how to increase the trading volume. For example, in the (T+2) settlement system currently used in India, Me is relatively low. By modeling:

$$ME_t = \frac{V_t}{\sigma_t \cdot L_t}$$

where the latency Lt is reduced using blockchain, then real-time settlement (T+ 0) can be imitated to increase the confidence of the market response and investors.

2. Cost Differential Model:

$$\Delta C = C_{traditional} - C_{blockchain}$$

This model quantifies cost savings from eliminating intermediaries like clearing corporations. Indian exchanges can use this to project savings by automating reconciliation and asset transfers via smart contracts.

3. Risk Exposure Model:

$$R = \rho \cdot \sigma_T + (1-\rho) \cdot \sigma_B$$

This helps SEBI and institutional investors evaluate how blockchain mitigates systemic risk by diversifying away from centralized systems.

Applicability of Mathematical Models in Solving Problems in the Indian Share Market

The findings and models presented in this study are significantly applicable to many dimensions of the financial circumstance. Using blockchain technology and mathematical modeling, this research provides a practical framework for the stock market functioning. After implementing the blockchain, financial institutions like stock exchange, clearinghouse, depositors and brokerage firms can use market efficiency models to measure transaction speed and liquidity improvement.

The cost variation model is useful for operating operational decisions that evaluate the financial feasibility of migrating from the Leggy system to the decentralized platform. Similarly, the risk exposure model helps determine the scope of reducing the systemic risk possible through the laser technology distributed to the regulators and institutional investors. Beyond technical operations, this research also has the consequences for producing policy. Central banks and financial regulatory monetary policy, compliance monitoring and digital property administration can adopt the analytical tools developed here to evaluate the effects of blockchain.

These models are suitable for developed and emerging markets, and can be extended to other property classes like bonds, derivatives and tocanized real estate. Educational institutions and researchers can apply this framework for simulation-based education and

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further innovation. In essence, this study connects the theory and the transaction, which gives the stakeholders a strategic approach, through which the ability of the blockchain to transform the stock markets can be used and maximum use. Mathematical models serve as a powerful tool for analyzing, predicting, predicting and optimization. In the context of the Indian stock market, these models can eliminate long -term inefficiency and risk by providing quantitative insights on how to improve blockchain technology. Given India's growing interest in digital financial infrastructure, the use of models is especially relevant, including activities such as RBI's Central Bank Digital Currency (CBDC) and National Stock Exchange (NSE) and Central Depository Service Limited (CDSL).

Specific Problems Solved in the Indian Context

Delays in Settlement:

Blockchain reduces T+2 settlement to T+0 using smart contracts and atomic swaps. NSE's sandbox already tests this in a controlled environment.

Fraud and Data Tampering:

The immutability of blockchain prevents backdated trade modification, useful for detecting pump-and-dump or insider trading cases, especially in small-cap stocks.

Lack of Transparency:

CDSL's blockchain initiative for share records of unlisted companies ensures transparency and reduces disputes over ownership claims.

High Transaction Costs:

Through peer-to-peer transfers, blockchain can eliminate brokerage and clearing fees, benefiting retail investors and increasing participation in tier-II and tier-III cities.

Inefficient Regulatory Oversight:
By modeling real-time audit-ability and ledger trace-ability, regulatory market can use mathematical tools for dynamically imitate and monitor the behavior. To solve the problems in the Indian stock market, I will guide you through a sample data-set and see how three models apply:

Given Data (Hypothetical but Realistic for the Indian Share Market)

For two trading systems: Traditional (T) and Blockchain-based (B)

Parameter	**Traditional (T)**	**Blockchain (B)**
Volume traded per hour V_t	5,000 shares	9,000 shares
Volatility σ_t	0.03	0.025
Latency L_t	2 days	0.01 day (T+0)
Transaction cost per trade C	₹12	₹3
Standard deviation (risk)	0.04	0.015
Correlation ρ	0.7	—

Model 1: Market Efficiency Model

$$ME_t = \frac{V_t}{\sigma_t \cdot L_t}$$

For Traditional:

$$ME_t = \frac{50000}{(0.03)2} = \frac{50000}{0.06} \approx 83{,}333$$

For Blockchain:

$$ME_B = \frac{9000}{(0.025)0.01} = \frac{9000}{0.00025} = 36{,}00{,}000$$

Market efficiency with blockchain is **~43 times higher**, driven by lower latency and volatility.

Model 2: Cost Differential Model

$\Delta C = C_T - C_B = 12 - 3 = 9$

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Each transaction is ₹9 cheaper on blockchain.

For 1 lakh transactions/day, the system saves **₹9,00,000 daily**.

Model 3: Risk Exposure Model

$$R = \rho \cdot \sigma_t + (1-\rho) \cdot \sigma_B$$

$$R = 0.7 \cdot 0.04 + 0.3 \cdot 0.015$$

$$= 0.028 + 0.0045$$

$$= 0.0325$$

Effective risk reduces from 0.04 (pure traditional) to **0.0325**, showing **18.75% risk reduction** using a hybrid system.

Interpretation:

These calculations show that blockchain:

Increases trading efficiency massively (43x)

Saves significant cost per trade

Reduces systemic financial risk

This supports the case for **migrating India's stock exchanges toward hybrid or fully blockchain-based models** for functions like settlement, reconciliation, and asset issuance.

Model Application in Equity vs. Option Trading in India using Blockchain

Assumptions:

We assume the following approximate values based on historical averages in Indian markets (e.g., NSE):

Metric	**Equity (Traditional)**	**Equity (Blockchain)**	**Options (Traditional)**	**Options (Blockchain)**
Volume per hour V(t)	10,000 shares	18,000 shares	2,000 contracts	3,500 contracts
Volatility σ_t	0.02	0.015	0.07	0.05
Latency L_t (days)	2	0.01	1	0.01
Cost per transaction C(₹)	10	3	18	6
Std. deviation (risk) σ	0.03	0.015	0.06	0.025
Correlation ρ (blockchain with traditional)	0.6	—	0.65	—

1. Market Efficiency Model

$$ME_t = \frac{V_t}{\sigma_t \cdot L_t}$$

Equity (Traditional):

$$ME_t = \frac{10,0000}{(0.02)2} = \frac{10,0000}{0.04} \approx 250,000$$

Equity (Blockchain):

$$ME_B = \frac{180000}{(0.015)0.01} = \frac{180000}{0.00015} = 1,20,00,000$$

Efficiency improves by 4800% (~48x).

Options (Traditional):

$$ME_t = \frac{20000}{(0.07)0.01} = \frac{20000}{0.0007} = 28,571$$

Options (Blockchain):

$$ME_B = \frac{3500}{(0.05)0.01} = \frac{3500}{0.0005} = 7,00,000$$

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Efficiency improves by ~24x in options trading.

2. Cost Differential Model

$$\Delta C = C_T - C_B$$

Equity:

$$\Delta C = ₹10 - ₹3 = ₹7 \text{ saved per trade}$$

Options:

$$\Delta C = ₹18 - ₹6 = ₹12 \text{ saved per trade}$$

If 1 million equity trades and 0.2 million options contracts are executed daily:

Equity savings/day = ₹7 × 1,000,000 = ₹70,00,000

Options savings/day = ₹12 × 200,000 = ₹24,00,000

Total daily savings: ₹94,00,000

3. Risk Exposure Model

$$R = \rho \cdot \sigma_t + (1-\rho) \cdot \sigma_B$$

Equity:

$$R = 0.6 \cdot 0.03 + 0.4 \cdot 0.015$$
$$= 0.018 + 0.006$$
$$= 0.024$$

Risk reduced from 0.03 to 0.024 → 20% reduction

Options:

$$R = 0.65 \cdot 0.06 + 0.35 \cdot 0.025$$
$$= 0.039 + 0.00875$$
$$= 0.04775$$

Risk reduced from 0.06 to 0.04775 → ~20.4% reduction

Metric	Equity Improvement	Options Improvement
Market Efficiency	↑ by 48x	↑ by 24x
Cost Per Trade	↓ ₹7	↓ ₹12
Systemic Risk	↓ by 20%	↓ by 20.4%

Applying blockchain with the mathematical models to Indian **equity** and **options** markets shows **dramatic improvements** in:

Market Speed and Efficiency

Operational Cost Savings

Systemic Risk Reduction

This validates blockchain's role not just in equity settlements but also in complex derivatives like options, helping regulators like **SEBI**, exchanges like **NSE**, and investors **reduce market friction** and **build more resilient infrastructure**.

Blockchain-Based Predictive Modelling for Stock Prices

The integration of blockchain technology with mathematical modelling enables more accurate, real-time prediction of stock prices by leveraging transparent and tamper-proof market data. Traditional financial markets often face latency, data silos, and manipulation risks that hinder accurate forecasting. Blockchain overcomes these issues by providing immutable records of every transaction, accessible in real-time. These characteristics allow for the construction of robust predictive models using verifiable inputs such as trade volume, volatility, latency, and systemic risk.

Predicting Stock Prices Using Blockchain and Mathematical Models

Assumption: You are using real-time, immutable blockchain data for trades, volume, and order book transparency.

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Model Adaptation: Price Prediction using Market Efficiency and Liquidity

$$P_{t+1} = P_t + \alpha \cdot \frac{V_t}{\sigma_t \cdot L_t} - \beta \cdot \text{Risk} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

P_{t+1} = Predicted price of the stock at time t+1

P_t : Current price of a stock at time t

V_t : Volume traded (extracted in real-time from blockchain)

σ_t : Market volatility

L_t : Transaction latency (very low in blockchain systems)

Risk: Risk index calculated using exposure models

α , β: Model-specific coefficients derived from regression analysis

"Use of Mathematical Models in Indian Equity and Option Trading"

That's an excellent application. Using mathematical models enhanced by **blockchain-generated real-time data**, you can indeed **predict and evaluate equity stock prices** (like **Reliance**, **Infosys**, **Tata Motors, Wipro, Hdfcbank ,** etc.) more accurately than traditional methods. Here's how your existing models can be adapted for **predictive analytics** when applied to real-time stock data via blockchain:

Example: Predicting Reliance Price

Suppose you extract the following real-time blockchain-based data:

Parameter	**Value**
P_t	₹1,500
V_t	1,20,000 shares
σ_t	0.018
L_t	0.005 (1 block ≈ 7 mins)
Risk	0.021
A	0.00003
B	45

Plug into model:

$P_{t+1} = 1500 + 0.00003 \cdot (120000 * 0.018 * 0.005) - 45*0.021$

$P_{t+1} = 1500 + 0.00003\ (0.018 * 0.005 * 120000) - 45 * 0.021$

$= 1500 + 0.00003\ (120000 * 0.00009) - 0.945$

$= 1500 + 0.00003\ (0.00009 * 120000) - 0.945$

$= 1500 + 0.00003 * 1333333.33 - 0.945$

$\approx 1500 + 40 - 0.945$

$= ₹1,539.05$

Predicted Price of Reliance at t+1 = ₹ 1,539.05

Why Blockchain Helps in Prediction:

Real-time data: You get up-to-the-second trade volumes and price movement.

Transparency: No data manipulation or delay.

Accuracy: Models like above perform better with live, tamper-proof inputs.

How to Use This for Multiple Stocks (Infosys, Tata Motors, etc.):

Run parallel models for each equity with:

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Blockchain-extracted trade data

Historical coefficient training using regression/ML

Periodic recalibration as data evolves

Use the model in **trading bots**, **portfolio optimizers**, or **regulatory surveillance**.

Application Example: Infosys

Assume blockchain-based trading data for Infosys stock at time t:

Parameter	**Value**
P_t	₹1,608
V_t	1,20,000 shares
σ_t	0.018
L_t	0.005 (1 block ≈ 7 mins)
Risk	0.021
α	0.00003
β	45

Calculation:

$$P_{t+1} = 1608 + 0.00003 \cdot (120000 * 0.018 * 0.005) - 45 * 0.021$$

$$P_{t+1} = 1608 + 0.00003\ (0.018 * 0.005 * 120000) - 45 * 0.021$$

$$= 1608 + 0.00003\ (0.00009 * 120000) - 0.945$$

$$= 1608 + 0.00003 * 1333333.33 - 0.945$$

$$\approx 1608 + 40 - 0.945$$

$$= ₹1,647.05$$

Predicted Price at t+1**: ₹ 1647.05**

Broader Use Case

This model can be extended to other major stocks such as Infosys, Tata Motors or even sectoral indices. With machine learning techniques, α and β can be trained dynamically, enabling the model to adapt to changing market behaviour. Blockchain-enabled predictive models provide investors, analysts and institutions with a powerful framework to predict prices more reliably. The combination of mathematical rigor with transparent real-time data makes traditional equity analysis more intelligent.

Advantages of Blockchain in Price Modelling.

Real-time input: No dependency on delayed market feeds**.**

Accuracy: Elimination of fake orders and outdated trade manipulation.

Transparency: Every transaction is verifiable, improving model trust.

Automation: Smart contracts can feed data directly into predictive models**.**

Real-Life Examples in the Indian Market

1. **NSE & SEBI Sandbox Projects**
   - **Use:** NSE has looked at Blockchain applications for e-voting, trade reporting and settlement, etc., for experimentation with the potential of DLT.
   - **Modelling Focus:** to determine latency τ_t reduced or to just utilize simplified ownership record S(t+1).
   - **Impact:** for investors, resulted in better efficiency of voting and to eliminate actions to reconcile data.
2. **Central Depository Services (India) Limited - CDSL on Blockchain**
   - **Use:** records of share transactions from unlisted companies on Blockchain.

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- **Modelling Focus:** defined secure ledger state transition S(t+1) = f(S(t), TXt).
- **Impact:** reducing risk of fraud (Rt↓) and tracking for regulatory compliance.

3. BankChain Consortium (ICICI Bank, Kotak, etc.)

- **Use:** Shared ledger capability: trade finance, asset tracking.
- **Modelling Focus:** Consensus mechanisms P_{cosensus} cross-institution ledger validation.
- **Impact:** Better accounting for collateral; decreases systemic risk.

4. International Financial Services Centres Authority (IFSCA), GIFT City

- **Use**: Testing tokenized securities and blockchain-based trade settlement.
- **Modelling Focus**: Simulation of ME and R_t across digital platforms.
- **Impact**: Enables real-time settlement trials and sandboxed cross-border trades.

5. RBI's Digital Rupee (CBDC) in Secondary Market Settlement

- **Use**: Pilot program where government securities were settled using CBDC on blockchain.
- **Modelling Element**: Near-zero latency $\tau_t \approx 0$, real-time atomic settlement.
- **Impact**: Proves that blockchain + CBDC can displace clearinghouses.

III. Opportunities of Blockchain in Share Markets

- Real-Time Settlement and Reduced Counterparty Risk
- Improved Market Liquidity and Participation
- Smart Contract Automation for Dividends and Voting
- Tokenized Assets and Fractional Ownership
- Enhanced Audit and Regulatory Reporting

IV. Challenges and Constraints

- Scalability and Network Congestion
- Regulatory Uncertainty and Jurisdiction Conflicts
- Legacy Infrastructure Integration
- Security Vulnerabilities in Smart Contracts
- High Energy Consumption in PoW-Based Chains

Case Studies and Implementations

- NASDAQ Linq Platform
- Australian Securities Exchange (ASX) with Digital Asset Holdings
- Swiss Digital Exchange (SDX)
- JP Morgan's Onyx and Quorum Initiatives
- Tata Consultancy Services (TCS) Quartz Blockchain for Finance

Future Outlook

Future development of blockchain technology in financial markets will depend on the combination of advanced mathematical modeling and assistant policy framework. On the technical front, game-condemnation models are essential to design fair and encouraging-relaxing market structures, so that the participants will be sure to work in a consistent manner with efficiency goals. In addition, agents -based simulations can help analyze the behavior of various market factors - such as investors, regulators, and intermediaries - because they interact in the blockchain ecosystem that is developing. These models can estimate the adoption methods, network effects and resistance from heritage systems. Moreover, in real time, different equations are used to model the flow of liquidity and property costs, which gives insights on how the blockchain platform treats different market volumes and shocks.

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From a strategic point of view, the deployment of Central Bank Digital Currency (CBDCS) is expected to significantly speed up the blockchain in the state-irregular markets, safe and programmable digital settlement tools will be provided. Interpolation standards like ISO 20022 are important to ensure that the blockchain system can effectively interact with traditional financial infrastructure. In addition, regulatory sandboxes provide a controlled environment to test innovative blockchain applications without full regulatory compliance, which makes it possible to develop fast feedback, safe experimentation and repetitive development. Together, these technical and strategic directions are freeing ways for skeletal, safe and inclusive blockchain-based financial markets.

- **Technological Directions:**

i. Game-theoretical models for market design

ii. Agent-based simulations for adoption dynamics

iii. Differential equations for liquidity modeling

- **Policy Trends:**

i. CBDC deployment

ii. Interoperability standards (e.g., ISO 20022)

iii. Regulatory sandbox experimentation

V. Conclusion

This research shows that proper planning, solid mathematical modeling, and strategic implementation can revolutionize the stock market by increasing transparency, reducing costs, and improving risk management. Future studies should focus on empirical testing of these models, cross-specific collaborations, and strategic experimentation, and that blockchain offers a potential solution to many long-standing stock market inefficiencies. It is essential to use mathematical models to demonstrate how blockchain-enabled platforms can enhance risk management, liquidity, and transparency. Strategic adoption in line with technical and regulatory requirements will play a key role in realizing its full economic potential.

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