Check for updates
https://doi.org/10.63062/trt/SG.103

THE REGIONAL TRIBUNE

Pages: 170 – 190 | Volume: 4 | Issue: 2 (Spring 2025) | ISSN (Online): 3006-8428 | DOI: 10.63062/trt/SG.103

Using AI to Predict and Mitigate Green Asset Bubbles in Financial Markets

Ramla Sadiq [1] Farah Yasser [2] Fatima Nawaz [3]

ABSTRACT: The global financial system is undergoing a profound transformation, driven by the rapid advancement of Artificial Intelligence (AI) and the escalating urgency of climate change. AI technologies—including machine learning, deep learning, and natural language processing—are redefining financial processes by improving efficiency, risk assessment, and decision-making in areas such as algorithmic trading, ESG scoring, and portfolio management. Concurrently, green finance has gained momentum as capital flows increasingly align with environmental sustainability goals, leading to the proliferation of green financial instruments. This study explores the intersection of AI and green finance, with a particular focus on AI's capacity to detect and mitigate green asset bubbles—instances where environmentally themed assets are overvalued due to speculative investment behavior. The research demonstrates that AI, through tools such as multi-scale confidence indicators and the Phillips–Shi–Yu (PSY) test, offers superior predictive accuracy over traditional econometric models by identifying complex market patterns and shifts in investor sentiment. Theoretically, the findings challenge the Efficient Market Hypothesis and expand agency and behavioral finance theories by illustrating AI's role in reducing information asymmetry and interpreting market psychology. Practically, AI strengthens risk management frameworks, improves internal controls, and ensures more responsible allocation of sustainable capital. Policy implications include the urgent need for clear AI governance structures, explainable AI mandates, and integration of AI-based risk tools into financial regulation. Addressing concerns around algorithmic bias, privacy, and energy consumption is essential to ensure AI contributes meaningfully to both financial stability and sustainable development.

KEYWORDS: Artificial Intelligence, Green Finance, Asset Bubbles, Financial Stability

[1] Associate Professor, Dr. Hasan Murad School of Management University of Management and Technology, Lahore, Punjab, Pakistan.
Email: ramla.sadiq@umt.edu.pk

[2] Associate Professor, Dr. Hasan Murad School of Management University of Management and Technology, Lahore, Punjab, Pakistan.
Email: farah.yasser@umt.edu.pk

[3] Lecturer, Dr. Hasan Murad School of Management University of Management and Technology, Lahore, Punjab, Pakistan.
Email: fatima.nawaz@umt.edu.pk

Corresponding Author: Ramla Sadiq
✉ ramla.sadiq@umt.edu.pk

Introduction

The global financial system is experiencing a dual transformation driven by the escalation of Artificial Intelligence (AI) and the growing urgency of climate change. AI, encompassing systems that accomplish tasks usually requiring human intelligence, for instance, learning, decision-making, and pattern recognition, is swiftly reshaping finance (Afzal, 2025). The expected doubling of AI investment by financial institutions indicates its move from a strategic edge to a foundational necessity (Fani, 2025).

Cite this Article: Sadiq, R., Yasser, F., & Nawaz, F. (2025). Using AI to Predict and Mitigate Green Asset Bubbles in Financial Markets. *The Regional Tribune, 4*(2), 170-190 https://doi.org/10.63062/trt/SG.103

Simultaneously, sustainable finance has escalated in significance, caused by environmental challenges and global climate commitments (Sani, 2025). Green finance, which includes financial instruments that support environmental sustainability, for instance, green assets, has experienced exponential growth (Gür, 2025). Governments and institutions are progressively aligning capital allocation with environmental objectives, pushing green assets to the front position of global financial portfolios (Tacchini, 2024).

Nevertheless, this conjunction of AI and green finance also presents complexity, particularly regarding green asset bubbles (Lehnert, 2023). As capital floods into green investments, pushed by both climate goals and speculative eagerness, the risk of mispricing worsens. These dynamics may raise bubble-sustained overvaluation resulting from unexpected crashes that threaten both market consistency and sustainable transitions (Van Eyden, 2023). Therefore, the timely detection and mitigation of green asset bubbles is crucial for guaranteeing financial resilience and assisting a seamless transition to a low-carbon economy (Uddin, 2024). Current studies discover the intersections of AI, finance, and sustainability across several subject areas:

AI in Financial Forecasting and Risk Management

AI and Machine Learning (ML) models are progressively utilized to analyze extensive, real-time data, offering improved predictive capability (Gür, 2025). Applications span fraud detection, trading algorithms, and portfolio optimization. For instance, AI-based anomaly detection tools are able to identify infrequent trading behavior and possible asset bubbles (Tacchini, 2024). Several studies demonstrate that AI adoption can decrease stock price crash risk (SPCR) by enhanced transparency and core controls, mainly in non-state-owned firms. Prominent models include Artificial Neural Networks (ANN), LSTM, SVM, ARIMA, Random Forest, and XGBoost (Manian, 2024).

Green Finance and Asset Dynamics

Green finance emphasizes funding projects that nurture environmental sustainability. Instruments such as green assets have become important to financing renewable energy and low-carbon infrastructure (Akram, 2025). The growth of directories such as the S&P Green Bond Index reflects growing investor appetite. AI models are being engaged to forecast green assets prices and assess ESG performance, assisting investors in handling risk and opportunity in sustainable finance. Integration of ESG metrics similarly supports improved portfolio diversification and long-term risk control (Singireddy, 2023).

Asset Bubbles and Detection Methodologies

Asset bubbles are periods of inflated prices that differ from intrinsic value, usually followed by crashes. Detection methods, for example, the Log-Periodic Power Law Singularity (LPPLS) model and the Phillips-Shi-Yu (PSY) test, have been utilized to recognize bubbles in equity markets (Maghyereh, 2022). These tools offer real-time monitoring and timely warning signals. Recent studies have discovered the notion of a "green bubble" driven by projected investment in green stocks, frequently influenced by investor sentiment and media narratives (Condon, 2022). Additionally, climate-related risks, both physical and transition-related, are progressively priced into asset valuations. AI-driven textual analysis is also being utilized to measure market sentiment and climate risk observation using news data (Arouri, 2025).

Identification of the Research Gap

Regardless of progress in AI-driven financial modeling and the rising importance of green finance, a prominent research gap exists: the devoted application of AI to identify and manage green asset bubbles remains unused (Han, 2024). Current research, every so often, centers distinctly on financial AI applications or on green finance development, hardly integrating them in the context of speculative bubbles (Zarrad, 2025).

Despite the fact that AI tools are used for forecasting and risk mitigation, they are mostly used for traditional asset classes. Green assets are distinctive because of policy influence, regulatory volatility, and investor sentiment, which entail specialized models (Abbas, 2025). Likewise, though machine learning methods have been useful to predict green bond prices, their capability to detect and mitigate speculative surges is less studied (Singireddy, 2023). Bubble detection methods like PSY or LPPLS exist; however, integration with AI for targeted real-time monitoring of green asset markets is missing (Vuković, 2025).

Theoretical Framework

This study draws upon multiple theoretical frameworks to build an inclusive model for AI's role in managing green asset bubbles:

Information Asymmetry Theory: AI can decrease asymmetry by making complex data transparent, facilitating investors to make informed decisions, thus decreasing market inadequacies that lead to bubbles (Arouri, 2025).

Agency Theory: AI can monitor managerial behavior, guaranteeing liability and decreasing the possibility of speculative activities that initiate bubbles (Joseph, 2025).

Efficient Market Hypothesis (EMH) and Behavioral Finance: While EMH assumes that markets reflect all available information, real market behavior often differs because of irrational investor sentiment. AI can help link this gap by including both rational indicators and sentiment analysis into forecasting (Akram, 2025)

Statistical Learning Theory: Forms the basis for AI algorithms used in classification, regression, and pattern recognition, essential tasks in bubble prediction (Arouri, 2025).

Institutional Theory: Describes how external pressures (e.g., regulatory, normative) affect AI adoption in green finance, shaping organizational strategies and risk frameworks (Li, 2024).

Resource-Based and Dynamic Capabilities Theories (RBT & DCT): These theories back up the view of AI and data infrastructure as strategic means that support institutions in dynamically responding to unstable, uncertain green asset markets (Malik, 2025)

Research Objectives and Questions

In response to the recognized research gaps, this study aims to discover how AI can be specifically used to detect and mitigate green asset bubbles. Main research questions comprise:

1. Which AI and ML models are most effective in recognizing and forecasting green asset bubbles in real-time?
2. How can AI be integrated into financial institutions' risk management frameworks to actively address the risks of green asset overvaluation?

3. What ethical and regulatory challenges arise from utilizing AI in green asset bubble detection, and how can governance frameworks address them?
4. How can AI-powered insights support policymakers in making adaptive, constant, and sustainability-aligned green finance regulations?

Theoretical Contribution

This research links AI and green finance literatures by concentrating on a developing, high-impact issue: green asset bubbles. It covers predictable financial risk management discourse by emphasizing AI's role in directing the exclusive dynamics of green markets (Abbas, 2025). It also supports theories like Agency and Information Asymmetry by representing AI's potential to decrease speculative behaviors and enhance transparency in sustainable finance contexts. Additionally, it evaluates the limitations of existing econometric bubble detection methods, offering a tailored AI framework for green asset forecasting (Oko-Odion, 2025).

Practical and Policy Contribution

For investors, the study offers risk understanding for improved decision-making in the unpredictable green finance domain. For financial institutions, it offers AI-based risk management models that can be integrated into current systems to boost early warning capabilities (Singireddy, 2023). For regulators and policymakers, it sketches governance encounters and suggests actionable direction to guarantee accountable AI use in green finance. The final goal is to support and stabilize green financial markets and protect the shift to a low-carbon, climate-sustainable economy (Kapar, 2023).

Structure and Flow

The paper follows a structured and rational flow designed to guarantee consistency, transparency, and academic precision. Section 1 presents the comprehensive context of the study and highlights its importance in the connection of Artificial Intelligence and green finance. Section 2 offers a broad literature review, producing key findings linked to AI applications in finance, the development of green asset markets, and present methods for asset bubble detection. Building upon this foundation, Section 3 recognizes the specific research gap, the inadequate integration of AI for the prediction and mitigation of green asset bubbles, and validates the need for concentrated investigation in this area. Section 4 builds the theoretical framework, drawing on economic, behavioral, and technological theories to assist the analytical approach of the study. Section 5 sketches the core research objectives and questions, providing a clear direction for the investigation. Finally, Section 6 explains the estimated offerings of the study, underlining its value for academic scholars, industry experts, and policymakers. This structured progression supports an attentive and in-depth investigation of how AI can be utilized to improve financial stability within the swiftly developing green finance sector.

Literature Review

The rise of Artificial Intelligence (AI) has extremely reformed multiple industries, mainly financial markets, and The natural resource economy (Tacchini, 2024). The digital era, with its unmatched connectivity, abundant data flows, and fundamental computational capabilities, has catalyzed the conjunction of finance and sustainability, giving growth to innovative models in financial forecasting and risk management (Gür, 2025).In

this scenario, green finance has become a critical frontline, with tools, for instance, green bonds, green loans, sustainability-linked, and ESG-oriented equities, together termed "green assets", serving to channel capital into environmentally advantageous projects (Arouri, 2025).

Regardless of their promise, green assets are not protected from market distortions and speculative excess (Gedikli, 2024). Certainly, issues are rising as for the possible development of “green asset bubbles,” where asset prices deviate considerably from essential fundamentals, driven by vivacious sentiment or policy-induced distortions (Yang, 2025)To respond to these risks, scholars have progressively revolved to AI and Machine Learning (ML), capitalizing their competences to process high-frequency, multi-dimensional data, detect non-linear patterns, and generate timely warning signals of bubble formation (Fani, 2025).

This literature review tends to combine the present research at the intersection of AI, financial markets, sustainable finance, and market bubbles (Vuković, 2025). Specially, it inspects how AI and ML have been used for financial forecasting and risk management; examines their role in the structuring, monitoring, and evaluation of green assets; assesses existing practices for bubble detection; and discovers the notion of climate-related asset bubbles (Phillips, 2024). To provide a comprehensible examination of the literature, this review is systematized into four interconnected sections:

AI in Financial Forecasting and Risk Management

The adoption of AI and ML technologies in finance is well-documented, presenting marked enhancements in forecasting accuracy, anomaly detection, and portfolio optimization (Zarrad, 2025).

AI systems leverage a mixture of structured data, such as time series of asset prices, yield curves, and macroeconomic indicators, and unstructured data, comprising news articles, social media sentiment, and alternative data sources similar to satellite imagery (Van Eyden, 2023). The processing of this high-dimensional data, in real-time, allows more responsive and vigorous risk management frameworks than those accessible by traditional econometric models (Afzal, 2025).

Predictive Analytics and Credit/Fraud Detection: ML models, comprising Random Forests, Gradient Boosting Machines, SVMs, and ANNs, have revealed superior performance in predicting loan defaults, identifying fraudulent transactions, and detecting anomalies in trading behavior at an initial stage in bubble detection (Akram, 2025). Specifically, anomaly detection frameworks utilizing autoencoder architectures or unsupervised clustering have highlighted unusual drift in asset prices related to risk events (Kapar, 2023).

Systemic Risk and Bubble Detection: AI-based models now support early warning systems aimed at detecting periods of financial instability (Arouri, 2025). For example, convolutional neural networks (CNNs) have been used to identify non-linear patterns in credit spreads, whereas LSTM networks are utilized to forecast volatility clusters. Reinforcement learning methods enable active portfolio rebalancing strategies that exploit risk-adjusted returns under shifting market management (Zheng, 2024).

Algorithmic Trading and Digital Advisory: Hedge funds and trading desks progressively use AI for high-frequency trading, volatility arbitrage, and pattern-based momentum strategies. Moreover, robo-advisors have extended access to algorithmic portfolio management, making accessible data-intensive investment services accessible to retail clients (Vuković, 2025).

Market Sentiment and NLP: Advances in NLP, mainly with transformer-based models like BERT and GPT, allow in-depth sentiment analysis of news flows, earnings calls, and regulatory disclosures (Gedikli, 2024). These models support count investor sentiment and enhance real-time pricing signals, connecting the gap between behavioral finance and quantitative modeling (Uddin, 2024).

Green Finance and Green Assets

Green finance includes a comprehensive collection of instruments designed to finance climate-compatible projects (Akram, 2025). These include, but are not restricted to, green assets, green equity indices, green loans, and ESG-linked derivatives.

Green Assets: The green asset market has grown ominously over the past decade, with global issuance exceeding USD 1 trillion (Huynh, 2023). Researchers have observed pricing dynamics and yield spreads, finding evidence that green assets may enjoy lower financing costs, though findings are mixed (Uddin, 2024). AI-enhanced models such as Random Forest and XGBoost have been used to forecast pricing based on macroeconomic variables, ESG disclosure metrics, and project-specific data, achieving accuracies above 90% in some market segments (Li, 2024).

Portfolio Construction and Climate Risk: AI-powered decision tools are utilized to enhance portfolios by incorporating climate risk variables, for example, carbon intensity, transition risk scores, and physical exposure metrics into risk-return frameworks (Kapar, 2023). These tools are custom-made to objectives like tracking a green ESG index or minimizing fossil-fuel-related risks while achieving target returns (Gedikli, 2024).

ESG Analytics and Impact Verification: NLP-driven analysis of corporate disclosures, regulatory filings, and media reports consents for automated ESG scoring and greenwashing detection (Abbas, 2025). Temporarily, satellite imagery and geospatial analysis, facilitated by ML, are active to observe project-level environmental consequences, for example, deforestation or renewable energy deployment, improving transparency and influence verification (Gür, 2025).

Technological Integration and Blockchain: Studies highlight the role of blockchain and RegTech solutions in representing digitally green assets, improving traceability, and facilitating decentralized data flows. They argue that accountable AI integration, combined with unassailable archive technology, creates a robust green finance ecosystem with strong governance and auditability (Zarrad, 2025).

Financial Bubbles and Detection

Financial bubbles, when asset prices differ considerably from intrinsic value, pose a threat to long-term economic stability. Detecting bubbles early can prevent systemic disasters.

Historical Perspectives and Methodologies: Academic and regulatory bodies have broadly studied major bubbles (e.g., 1840s railway mania, subprime crisis), emerging statistical tools like PSY and LPPLS to recognize super-exponential price speeding up (Condon, 2022). The PSY method, in particular, detects volatile behavior through frequently applied right-tailed unit root tests, a method extensively used by central banks (Singireddy, 2023).

Limitations of Traditional Approaches: While effective ex post, these approaches frequently flop in real-time due to data interference, biases in parameter selection, and the absence of adaptability to structural shifts.

They depend on windowed estimation and may miss indirect shifts in risk establishment before amplification (Tacchini, 2024)

AI-Powered Bubble Forecasting: Current works establish the promise of ML algorithms for bubble detection. For instance, neural networks trained on synthetic bubble-labeled time series outdo econometric benchmarks (Gedikli, 2024). Hybrid models connecting LPPLS feature extraction with RF or Gradient Boosting classifiers demonstrate enhanced recall and accuracy rates in live trading simulations (Arouri, 2025).

Behavioral Drivers and Sentiment: Behavioral finance improves bubble research, clarifying excess volatility through cognitive biases, herd dynamics, and overconfidence. Empirical studies show that sentiment proxies resulting from consumer confidence surveys or NLP analysis of social media significantly predict deviances from important values, highlighting the requirement to combine behavioral inputs with quantitative models (Huynh, 2023).

Climate Risk and Green Bubbles

Concerns over “green bubbles” reflect the exclusive characteristics of climate-aligned assets.

Physical vs. Transition Risk: Climate risk is commonly characterized as: (a) physical risk associated with extreme weather events, and (b) transition risk related to regulatory, technological, or policy shifts. Both types use price pressure on green assets; for example, an unanticipated policy difficulty might trigger unexpected repricing, similar to bubble deflation (Kapar, 2023)

News-based and NLP Metrics: Scholars have established news-based directories specific to climate risk tracing terms such as "carbon tax," "green stimulus," or "ESG scandal." These real-time sentiment indicators detect transitions in investor perception and can aid as pioneers to distortions in green asset valuation (Arouri, 2025), (Oko-Odion, 2025).

Green Stock Market Dynamics: Meta-analyses drawing parallels to the dot-com bubble recommend that green equity directors knowledgeable of explosive growth forgo broader market meetings (Maghyereh, 2022). While "positive bubbles" may speed up essential capital flows into green infrastructure, they also represent portfolios to sharp corrections, particularly when sentiment-driven capital withdraws (Condon, 2022).

Asset Correlations and Hedging: Studies using multivariate GARCH and copula models specify volatility spillovers from green assets to traditional equities, fixed income, and commodities (Gür, 2025). Nonetheless, inadequate research suggests that AI can use dynamic hedging alterations in portfolios comprising green assets, ESG stocks, and derivatives, mainly in response to early warning signals (Vuković, 2025).

Emerging Frontiers: DeFi and Tokenized Green Assets: Although decentralized finance (DeFi) and blockchain-based green tokens show new investment ways, they also generate fresh exposures (Singireddy, 2023). The research is based on how these promising markets interrelate with traditional markets or respond to algorithmic models, especially if green-coded tokens are subject to tokenomic assumptions or price manipulation (Zheng, 2024).

Critical Analysis and Synthesis

- The previous review highlights numerous strengths in current research:

- Technical Advancement: AI models validate clear dominance in anomaly detection, credit scoring, and burst prediction, due to their capability to handle high-dimensional, non-linear data competently (Fani, 2025).
- Data Integration: Linking structured financial data with unstructured text and alternative data has augmented transparency and predictive performance (Lehnert, 2023).
- Behavioral Insights: Adding behavioral delegations resulting from sentiment analysis has enhanced the early detection of speculative deviations (Sani, 2025).
- However, critical limitations continue:
- Data Gaps: High-frequency, quality-checked datasets stay erratic for green assets, particularly for evolving instruments like ESG-linked loans (Uddin, 2024).
- Algorithmic Bias: Without fairness metrics and bias mitigation strategies, models can support historical inequities or exaggerate short-term hype over long-term sustainability (Arouri, 2025).
- Explainability: The "black-box" nature of deep models hinders regulatory approval in contexts demanding accountability and auditability (Gedikli, 2024).
- Ecosystem Integration: Numerous institutions lack the infrastructure and personnel to incorporate AI systems into existing workflows, mostly when integrating financial risk, impact dimension, and compliance (Joseph, 2025)

Theoretical Foundations

A cross-theoretical foundation helps position these empirical findings within a wider academic dissertation:

Information Asymmetry Theory

AI diminishes information asymmetry by allowing for rough analysis of discoveries and market signals in near real-time. This improves transparency, lowers asymmetry-driven risk, and can anticipate speculative flows determined by dense or misleading information (Afzal, 2025).

Agency Theory

AI functions as an internal governance mechanism, dropping agency costs by systematizing monitoring and supporting managerial behavior with shareholder and environmental interests (Yang, 2025). This dynamic is mostly applicable in green finance, where environmental purposes may not directly align with traditional financial incentives (Sani, 2025).

EMH vs. Behavioral Finance

Evidence from bubble-detection systems challenges the strong-form EMH. In its place, behavioral finance offers explanatory power. AI, through the swift integration of both fundamental and sentiment data, can link this divide, incorporating rational signals while analyzing irrational sentiment-driven behavior (Malik, 2025).

Institutional Theory

Institutional theory describes AI implementation through normative, mimetic, and coercive pressures, particularly noticeable in green finance, where ESG revelation mandates, peer benchmarking, and sustainability standards shape organizational behavior (Li, 2024).

Resource-Based View & Dynamic Capabilities

AI-related assets, for example, proprietary algorithms and data infrastructure, are valuable, rare, and difficult to imitate. In the meantime, dynamic capabilities enable organizations to develop, reconfigure, and reorganize these assets quickly in reaction to environmental fluctuations or risk signals (Manian, 2024).

Incorporating these theories allows for a holistic framework where AI improves transparency and governance, supports market efficiency, and prepares institutions with technical and organizational tools to detect and achieve green asset bubbles effectively.

Research Gaps and Justification

Despite considerable advancements, some research gaps remain:

Standardization and Regulatory Consistency: While jurisdiction regulations exist, a global framework for AI integration in green finance is vague (Van Eyden, 2023). Proportional studies and normative rules are required to facilitate cross-border deployment.

Empirical Scope and Validation: Much of the literature is context-specific, particularly focusing on firms in China or Europe. Comprehensive validation efforts are compulsory across different market governments, evolving economies, and long-term horizons (Omopariola, 2021).

Integration of Portfolio Hedging: Research derives multi-asset frameworks that enhance dynamic hedging across green assets, volatility rules, and traditional tools with AI-enabled recalibration grounded on early-warning signals (Phillips, 2024).

Ethical and Governance Deliberations: Fairness, accountability, and environmental reliability remain under-addressed (Singireddy, 2023). There is a requirement for research into bias mitigation, comprehensive design, and ESG conflict management within AI-driven financial tools (Akram, 2025).

Green Bubble Identification: AI models have been applied to overall bubble prediction; however, few have concentrated clearly on green asset bubbles scenarios where policy announcements, climate narratives lead to extreme price activities decoupled from fundamentals (Condon, 2022).

Interdisciplinary Linkages: Gaps continue in connecting AI-based financial modeling to life-cycle environmental valuations, e-waste examination, circular economy abilities, or agricultural-tech-enabled sustainability areas where financial and environmental modeling must merge (Gür, 2025).

Addressing these gaps by emerging incorporated, understandable, and ethically administered AI frameworks would allow improved detection and proactive mitigation of green asset bubbles, firming both market resilience and climate transition necessities.

Theoretical and Conceptual Frameworks for Using AI to Predict and Mitigate Green Asset Bubbles in Financial Markets

The emerging transition of Artificial Intelligence (AI) and Machine Learning (ML) technologies is creating a stimulus shift in several industries, such as the financial sector and the natural resource economy as a whole (Maghyereh, 2022). This revolution introduces a new epoch of previously unknown connectivity, data, and computing capabilities. Among the least explored but arguably the most promising areas of such change is

the ground of green finance, where the capital is investing in environmentally friendly projects and instruments (Zarrad, 2025).

In the current paper, a detailed theoretical and conceptual framework has been provided, which responds to the question of how green asset bubbles can be mitigated either by the use of AI or by strategically deploying it more as a method of predicting green asset bubbles. This framework will allow integrating developed financial theories and current AI strategy to improve resilience and lessen the risks caused by the system, and lead to a more sustainable global financial system.

In order to process the interactivity between AI technologies, green assets, and the stability of the financial market, the research relies on some economic and organizational theories They are Efficient Market Hypothesis (EMH) and its critics, Behavioral Finance, Financial Instability Hypothesis, Agency Theory, Information Asymmetry Theory, and Institutional Theory (Phillips, 2024). All these frameworks offer a slightly distinct but mutually enhancing lens through which the role of bubble formation, the involvement of AI, and the preservation of systemic stability may be viewed.

Market Efficiency, Bubbles, and Behavioral Finance

An effective application of the Efficient Market Hypothesis (EMH) as defined by Fama (1970) is that all of the information available to a financial asset is reflected in the price and that all assets are priced competitively (Joseph, 2025). In the robust form of the EMH, it is assumed that the prices incorporate all the public and the non-public bits of information, but in the semi-strong form, prices are assumed to incorporate all the public information, and in the weak form, the history of the prices is said not to be able to predict anything further (Lehnert, 2023). According to the EMH school of thought, asset bubbles, which refer to sharp asset price inflation, are not supposed to exist theoretically since market participants would immediately take advantage of the mispricing to rectify it (Maghyereh, 2022).

This theoretical deficiency is practically filled in by Behavioral Finance, which incorporates the application of psychology to view how investors overcome careful rationality. Behavioral finance implies that mispricing and the occurrence of bubbles may exist due to cognitive biases and emotional aspects (Yang, 2025).

The Financial Instability Hypothesis and Systemic Risk

The Financial Instability Hypothesis (FIH) of Hyman Minsky assumes that the severe downturns are caused by years of economic stability that cause risk-taking to rise and the imprudent lending/investment practices to diminish (Tacchini, 2024). Such practice ultimately creates the environment of the speculative bubble and the financial crisis that will follow. A finance system with localized asset bubbles, especially in high-growth areas such as green finance, may cause spillover effects that pose a threat to the whole financial system in the age of globalization (Van Eyden, 2023). In this regard, AI may become a preventative measure of systematic risk (Phillips, 2024). In contrast to the classical models, which frequently fail at identifying non-linearities and feedback loops, the advent of AI models would reveal the hidden correlations and highlight the growing vulnerabilities, including anomaly detection algorithms, ensemble learning, and the popularization of our increasingly popular models, neural networks (Vuković, 2025). One unexpected benefit of AI is that it can effortlessly analyze massive, unstructured, and real-time data (i.e., transactions in the market, geopolitical news, ESG reports) and is in a unique position to highlight risk factors well in advance before they experience a full-blown crisis (Zarrad, 2025).

Agency Theory, Information Asymmetry, and Internal Control

Agency Theory puts under the spotlight the interpersonal conflicts that may occur among managers (agents) and shareholders (principals), and in many cases, it may lead to decision-making that may be on a short-term interest aspect rather than on the creation of long-term value (Gür, 2025). Information Asymmetry Theory goes even further to show that when information between the participants of the market is unequal, the risk may increase significantly because the firms that are hiding or withholding negative information may increase the chances of risk (Afzal, 2025).

The main argument is that the internal control quality can be improved through AI adoption, and this in turn will decrease the agency problem and information asymmetry, which will lead to a decline in agency problem and information asymmetry (Li, 2024). The managers also tend to withhold or selectively disclose negative information and disclose only when the negative accumulated information is so much that failure to disclose it can result in sudden price crashes (Zheng, 2024). AI also helps businesses with the transmission of data inside the companies faster and places more emphasis on disclosing this data, making it harder for firms to conceal and minimizing financial strains at a time when companies are using digital technologies to comprehensively gather and analyze data at multiple stages (Maghyereh, 2022). Such an increment in information symmetry and internal control capacity prevents companies from making decision-making errors and increases their investment effectiveness (Joseph, 2025). It is within this theoretical framework on which the research is based on establishing a means of justification on how the internal uses of AI in firms contributes to larger market stability through the reduction of idiosyncratic risks that might otherwise collectively form part of systemic problems given the overwhelming importance of transparency and accountability related to green investments (Tacchini, 2024).

Institutional Theory and Responsible AI Adoption

Institutional Theory focuses on the shaping of organizational behavior by the outside powers through regulatory demands, social expectations, and industrial specifications. It determines three main mechanisms of change, namely, coercive (regulatory), normative (cultural), and mimetic (competitive) pressures (Fani, 2025).

Regulatory agencies are calling for more transparency, accountability, and ethical use of AI tools in green finance. It is not only required that the companies adopt AI, but also that they adopt it responsibly. This consists of the introduction of Explainable AI (XAI) models that can be audited by the regulators and considered eligible by the stakeholders (Oko-Odion, 2025). Institutional Theory is thereby instrumental in ensuring that AI implementation is kept in line with the dynamic ethical guidelines and regulations in such a way that its input is positive in the context relevant to sustainability goals (Maghyereh, 2022).

Core Concepts and Their Relationships

- **AI & ML Tool:** AI & ML tools include LSTM, ANN, SVM, XGBoost, NLP, and reinforcement learning technologies that offer predictive and analytical services (Gedikli, 2024).
- **Green Assets:** These constitute green bonds, ESG-screened equities, and carbon credit derivatives that purport to provide financial returns as well as some ecological benefit (Abbas, 2025).

- Asset bubbles: These refer to the boom in the price of an asset devoid of its fundamentals triggered by speculation, misinformation, or sentiment (Condon, 2022)
- Financial Market Dynamics: This would include liquidity, volatility, investor confidence, and actions of transaction (Fani, 2025)
- Risk Management and Governance: Add fraud detection, portfolio optimization, and credit risk analysis, regulatory compliance (Oko-Odion, 2025)

Integrated Conceptual Model

The theoretical frameworks also form the conceptual model that explains how AI can forecast and prevent the risk of green asset bubbles:

Phase 1

Artificial Intelligence-based Green Asset Bubble in a pure form, the potential of AI lies in predictions and real-time data analysis.

- Both financial and macroeconomic data, environmental information, and unstructured text, such as news and social media, are the various sets of data that AI systems collect to analyse green assets. The process of standardization and cleaning of data is then undertaken to review consistency and accuracy (Abbas, 2025).
- The ANN, Random Forest, SVM, LSTM, and Gradient Boosting are AI/ML models to identify asset bubbles because they engage in non-linear and complex patterns that are not found when traditional methods are used (Han, 2024). The progress of new advanced techniques like LPPLS with Confidence Indicators and the PSY method improves the multi-scale bubble detection on time-series analysis and statistical test (Maghyereh, 2022).
- The AI algorithms combine green-related signals such as ESG ratings and plans to reduce emissions in order to verify the sustainability according to the statements, identify the cases of greenwashing, and reveal the missing link compared to both common bubble detection models (Vuković, 2025).

Phase 2

AI-Based Green Asset Bubble Reduction: This phase is concerned with getting an AI to deal with the effects of identified green asset bubbles, which is in accordance with the principles of financial stability, agency theory, and information asymmetry.

Improved Risk Management: AI improves many areas of risk management:

- Closer Credit Risk Analysis: AI considers borrowers' default risk on green projects much better than the conventional scoring (Lehnert, 2023)
- The AI models can use reinforcement learning and other algorithms to efficiently optimise green portfolios with a dynamic risk-reward-sustainability trade-off (Tacchini, 2024)
- AI will help policymakers develop evidence-based structures around green finance, and Explainable AI will guarantee that the process of green finance development is transparent, accountable, and ethical (Yang, 2025).
- Feedback Mechanisms is a method to make sure that the model is improved every time it is implemented, making the governance ecosystem self-learning (Malik, 2025).

Assumptions and Boundaries

The provided conceptual framework is based on a number of assumptions, e.g., (1) there exist adequate and quality data (financial data, environmental data, textual data) to train AI models and use in real-time applications (Zarrad, 2025). (2) AI models have the capacity to properly model the complex, non-linear dynamics that motivate prices of green assets and population of bubbles (Phillips, 2024). To place and use AI-driven solutions requires (3) the technical expertise, organizational capacity to integrate them, and effectively utilize them, within the financial institutions as well as regulatory bodies (Vuković, 2025). It has specific limits, restricting itself to publicly traded green assets and not involving the macroeconomic feedback loops in general, which could be extended in future flips.

Addressing Literature Gaps and Utility

This framework consists of four important parts:

1) Two-fold Nature of AI: It incorporates both the predictive and mitigation tasks, which have not been mentioned previously in the current literature. (Han, 2024).
2) Green Asset Insight: Unlike generic bubble models, it customizes bubble detection to issues of a sustainability focus (Abbas, 2025).
3) Theory-Practice Bridge: Applies empirical theories to assist in the real-life applications of AI (Lehnert, 2023)
4) Ethical and Regulatory Focus: Paying attention to governance and transparency that are usually not addressed during technical research on AI (Uddin, 2024)

Synthesis and Integration

The framework elaborates the synthesis of the theories of market efficiency, behavioral psychology, systemic risk, agency conflict, and institutional pressures to filter the unified picture of the groundbreaking role of AI in green finance (Sani, 2025). AI cannot only be viewed as a forecasting device, but it is also a force of accountability, risk management, and ethical financial behavior (Singireddy, 2023)

The Role of Artificial Intelligence in Predicting and Mitigating Green Asset Bubbles in Financial Markets: A Case Study Synthesis

The rapid integration of Artificial Intelligence (AI) and Machine Learning (ML) technologies into financial markets marks a significant paradigm shift in the way financial risks and phenomena are understood and managed (Arouri, 2025) In recent years, attention has increasingly turned to a specific subset of this challenge: green asset bubbles, which are linked to the rapidly expanding domain of green finance (Tacchini, 2024). Green finance discusses financial investments that are directed toward environmentally sustainable projects, such as renewable energy, energy efficiency, clean transportation, and sustainable agriculture (Phillips, 2024). These studies demonstrate the potential of advanced analytics to enhance financial decision-making and provide foresight into volatile market dynamics.

Case Study 1: Detecting Speculative Trends in Green Technology Stocks

In a landmark study, Lehnert (2023) investigated speculative dynamics in the green energy segment of the stock market. The research employed the (Manian, 2024) recursive testing procedure and dating algorithm to

identify signs of speculative price behavior, specifically focusing on the S&P 500 index. The study identified an explosive growth pattern beginning in mid-2023, coinciding with heightened investor enthusiasm for green technologies and government stimulus packages supporting clean energy (Phillips, 2024). These findings confirmed theoretical expectations that technological revolutions—especially in sectors seen as "the next big thing" can create conditions ripe for asset bubbles. This emphasizes how quantitative AI-driven diagnostics can uncover unsustainable market behaviors that might be invisible through traditional financial tools (Van Eyden, 2023)

Case Study 2: AI-Powered Financial Bubble Forecasting in Emerging Markets

(Manian, 2024) extended the discussion to the Indian financial market, where they applied seven different binary classification ML algorithms to detect historical bubbles and predict future occurrences. This included methods such as Artificial Neural Networks (ANNs), Random Forests, and Gradient Boosting Machines. Their model successfully identified bubble events around the years 2022 and 2024, validating the efficacy of advanced algorithms in emerging markets where data irregularities are common and traditional indicators may fail (Condon, 2022) The study underscored the adaptability of ML models to different economic contexts and their ability to learn from patterns over time, providing high-accuracy forecasting of potential market distortions (Tacchini, 2024).

Case Study 3: Mitigating Greenwashing with AI-Enhanced Transparency

Greenwashing, the practice of misleading stakeholders about the environmental credentials of investments, poses a significant threat to the credibility and effectiveness of green finance. In this context, Joseph (v) conducted a study to explore the use of AI tools to mitigate such fraudulent practices. Their research highlighted how Natural Language Processing (NLP) and sentiment analysis could be applied to financial disclosures, corporate reports, and media content to detect inconsistencies and red flags (Gedikli, 2024). Additionally, ML models were used to assess the reliability of green bonds, thereby improving investor confidence. This study contributes an important dimension to the literature by showcasing AI's role not only in financial forecasting but also in governance and ethics in green finance (Abbas, 2025).

Case Study 4: Reducing Stock Price Crash Risk Through AI in Chinese Markets

A different perspective is offered, investigating how AI adoption among A-share listed companies in China impacted the Stock Price Crash Risk (SPCR) (Han, 2024). Using a combination of internal data and publicly disclosed AI initiatives, the study found a significant reduction in crash risk for firms actively integrating AI tools (Vuković, 2025). This impact was largely attributed to improvements in internal control systems, suggesting that AI applications can not only optimize operational efficiency but also contribute to broader market stability. By proactively identifying and managing financial irregularities, these technologies help prevent the build-up of risks that could otherwise culminate in sudden market corrections (Maghyereh, 2022).

Case Study 5: AI-Based Forecasting of the S&P Green Bond Index

In the fifth case, the focus is on the development of predictive models for the Global S&P Green Bond Index, using a suite of AI-supported machine learning tools (Gür, 2025). Among the models tested, the Rational Quadratic Gaussian Process Regression (GPR) model emerged as particularly accurate. The study showcased

how AI-powered forecasting tools can support better decision-making by investors and regulators alike, ensuring a more accurate valuation of green bonds and reducing the risk of mispricing, which is often a precursor to asset bubbles (Condon, 2022)

Analysis and Synthesis of Findings

While some studies, like those of Lehnert (2023) and Manian & Kayal (2024), concentrate on predictive applications identifying when and where bubbles might occur others (Manian, 2024), such as Joseph et al. (2025) and Li et al. (2024), focus more on the preventive and regulatory dimensions of AI, including transparency and internal controls. This duality highlights the multifunctional utility of AI tools in financial markets (Li, 2024).

Furthermore, the findings collectively support the integration of AI into mainstream financial practices, particularly within green finance, where data-driven insights are essential to avoid distortions caused by overhype, misinformation, or speculative exuberance (Joseph, 2025).

Theoretical Implications

The empirical evidence provided by these studies also lends support to several important financial theories. Notably, the Information Asymmetry Theory is reinforced by findings that demonstrate how AI helps bridge informational gaps between market participants. By making data more accessible, timely, and interpretable, AI reduces uncertainty and allows for more rational decision-making (Akram, 2025)

Similarly, Agency Theory is relevant in explaining how AI can be used to align incentives within firms (Arouri, 2025). Through continuous monitoring and enhanced governance mechanisms, AI limits the ability of agents (for instance, managers) to act in their own interest at the expense of principals (e.g., shareholders). This is particularly pertinent in the context of green finance, where the risk of opportunistic behavior such as greenwashing or misreporting sustainability metrics is high (Condon, 2022).

Remaining Challenges and Research Gaps

Despite these promising developments, several challenges must be addressed before AI can be fully leveraged in green finance (Tacchini, 2024). Algorithmic bias is a major unease, especially when models are trained on past data that may reflect past inequities or market exclusions. If unaddressed, these biases could result in discriminatory outcomes or the systematic exclusion of small-scale green projects (Zarrad, 2025)

Additionally, data privacy and cybersecurity represent growing threats. Financial institutions must safeguard sensitive information while still enabling the free flow of data required for robust AI training and deployment (Phillips, 2024). This creates a delicate balance between innovation and compliance.

Another tenacious issue is the lack of interpretability in many AI models. Often referred to as the "black-box" problem, this limitation makes it difficult for regulators and stakeholders to understand the rationale behind AI-generated predictions (Oko-Odion, 2025). Legacy system integration is also a significant operational hurdle. Many financial institutions still rely on outdated infrastructure, which can be incompatible with the demands of modern AI systems. Overcoming this requires substantial investment and a long-term commitment to digital transformation (Gedikli, 2024).

Contribution to Research and Practice

The case studies discussed here provide empirical depth to the research concept of using AI to forecast and mitigate green asset bubbles (Li, 2024). They validate that AI is more than a supplementary tool; it is a disruptive innovation capable of fundamentally reshaping financial ecosystems.

These studies illustrate AI's role in:

- Detecting early warning signs of asset bubbles
- Enhancing internal governance and compliance
- Preventing unethical practices, such as greenwashing
- Improving forecasting models for green financial instruments

Practically, this implies that stakeholders, including investors, regulators, and policymakers, must prioritize the development of robust, ethical, and interpretable AI models, underpinned by high-quality data. In parallel, educational and regulatory institutions must evolve to keep pace with technological advancements.

The path forward involves balancing innovation with regulation, ensuring ethical deployment, and fostering collaboration between technologists, financial experts, and environmental advocates. Ultimately, the strategic use of AI in green finance can promote a more resilient, transparent, and equitable financial system, one that supports long-term environmental and economic sustainability.

Conclusion

A revolutionary change in the way that financial stability is understood and managed in the framework of sustainable development is shown by the theoretical investigation into the use of artificial intelligence (AI) for forecasting and preventing green asset bubbles in financial markets (Van Eyden, 2023).In order to show how AI's sophisticated analytical powers are set to revolutionize conventional financial forecasting, risk management, and policy formulation, particularly with regard to the emerging green economy this study has methodically incorporated insights from a wide range of literature (Kapar, 2023)

Summary of Key Findings

According to our analysis, the rise of artificial intelligence (AI) is radically changing a number of industries,

including the financial markets and the economy reliant on natural resources, thanks to its unparalleled computational capacity, connectedness, and information accessibility (Gedikli, 2024). The main conclusion is that artificial intelligence (AI), with its advanced machine learning (ML) algorithms, deep learning (DL) approaches, and natural language processing (NLP) techniques, provides an unmatched ability to process large, complex datasets, spot complex patterns, and produce extremely accurate predictive insights that surpass traditional econometric models (Tacchini, 2024).

The study specifically emphasizes how well AI can identify and predict financial bubbles. Research using techniques such as multi-scale confidence indicators and the Phillips, Shi, and Yu (PSY) procedure shows that AI has a higher predictive capacity than conventional statistical approaches, correctly predicting times of stock market boom and bust (Oko-Odion, 2025). AI's capacity to decipher market signals via sentiment analysis and natural language processing (NLP) improves this identification and offers more profound insights into market trends and investment opportunities (Sani, 2025). For instance, using AI to forecast and control carbon

emissions in supply chains gives financial benefits in addition to sustainability by making green finance options like carbon credits and sustainability-linked loans accessible (Lehnert, 2023).

The results also provide insight into how AI affects risk and financial market behavior. By improving internal control quality and encouraging information symmetry within businesses, especially in non-state-owned and non-foreign organizations, AI adoption has been demonstrated to dramatically lower stock price crash risk (SPCR) (Zarrad, 2025). Research also shows that green bonds, ESG indexes, and conventional assets are dynamically connected and effective at hedging, and AI is helping to better understand the benefits of diversification and volatility spillovers (Maghyereh, 2022).

Theoretical Implications

Particularly when considering market anomalies and the function of information, the knowledge gained from this study greatly expands and improves upon current financial theories. The efficient market hypothesis and rational expectations models are two examples of traditional theories that have tried to explain bubble phenomena. However, AI's ability to identify "irrational exuberance" and "non-linear relationships" calls into question the notions of perfectly rational actors and instantaneous information dissemination (Abbas, 2025). The Heterogeneous Market Hypothesis, which contends that market players function on many time scales and information sets, is in line with this. AI is particularly well-suited to simulate this complexity (Uddin, 2024).

By incorporating behavioral and technology aspects into financial modelling, the study also presents fresh viewpoints. Stock market bubbles are demonstrated to be impacted by investor mood as measured by AI-driven sentiment analysis, which enhances behavioral finance by offering instruments to measure and forecast the impacts of collective market psychology (Condon, 2022). By presenting AI expertise, data analytics, and emanations forecasting tools as valuable, uncommon, and unique resources that help businesses gain a competitive edge through sustainable practices, the convergence of AI with green finance also reinterprets Resource-Based Theory, Strategic Choice Theory, and Dynamic Capabilities Theory (Gedikli, 2024).

Practical Implications

A wide spectrum of financial market participants and industry stakeholders can benefit greatly from the findings' significant practical implications, which give them cutting-edge tools and methods to help them deal with the complexity of contemporary finance, especially in the green economy (Li, 2024).

AI gives investors and portfolio managers vital early warning signs for financial bubbles, allowing them to make better-informed and quicker decisions on asset allocation, purchasing, and selling tactics (Maghyereh, 2022). AI's ability to evaluate "dynamic connectedness" and "volatility spillovers" between different asset classes, such as traditional stocks, green bonds, and AI-related stocks, is crucial for maximizing portfolio diversification and hedging tactics, particularly in times of market stress. This improves portfolio stability, lowers total volatility, and aids in risk management (Manian, 2024)

AI can be used by businesses and financial institutions to greatly enhance their risk management systems. By increasing the precision of credit scoring, scam detection, and liquidity analysis, AI-driven risk assessments lessen systemic vulnerabilities and boost investor trust (Omopariola, 2021). In the realm of green finance, artificial intelligence (AI)-powered models help evaluate the feasibility of green projects, guarantee

transparency in effect verification, and maximize capital allocation for truly sustainable projects, all of which help to avoid "greenwashing" (Zheng, v).

In the end, this improves investment efficiency and lessens managerial opportunistic behavior by standardizing executive decision-making, streamlining information flow, and improving data analysis (Fani, 2025). In line with changing sustainability standards and regulatory requirements, companies that make strategic investments in AI-driven sustainability projects may also improve their brand image, draw in eco-aware investors, and ensure long-term financial stability (Gür, 2025).

Policy Implications

In order to maintain financial stability, advance sustainability, and reduce possible hazards, proactive and flexible policy responses are required in light of the quick integration of AI into financial markets, particularly with regard to green assets (Han, 2024).

First and foremost, regulatory agencies need to create precise AI governance guidelines for financial organizations. To improve regulatory supervision and promote confidence among financial stakeholders, this involves creating standardized frameworks for risk audits, bias identification, and AI model validation (Tacchini, 2024). Enforcing the use of Explainable AI (XAI) approaches is a crucial suggestion. This will solve the "black-box" problem by guaranteeing that regulators can understand and audit AI-driven risk assessments (Arouri, 2025).

Second, authorities should include cutting-edge AI tools for real-time bubble detection and early warning systems into financial supervisory processes in order to improve market stability. In order to improve financial supervisory capacities and guarantee general market stability, governments should aggressively encourage the implementation of AI (Gedikli, 2024).

Thirdly, policies that encourage the responsible use of AI in this industry must be developed in order to propel green finance projects (Joseph, 2025). To enable safe data exchange for sustainability evaluations, this entails encouraging public-private cooperation and setting precise data protection norms. In order to ensure an equal transition and reduce any potential negative effects of AI on family energy usage and energy poverty, it is also imperative to improve labor protection laws (Huynh, 2023).

Lastly, it is critical to address ethical issues and any hazards related to the deployment of AI. Protecting data privacy, reducing algorithmic bias, and controlling the ecological impact of AI systems themselves should be the main priorities of policymakers (Van Eyden, 2023). This calls for a well-rounded strategy that promotes creativity while guaranteeing justice, accountability, and social responsibility (Manian, 2024).

Limitations and Future Research

Notwithstanding the noteworthy theoretical advancements and practical ramifications, this study admits a number of shortcomings that offer opportunities for further investigation. One of the main drawbacks is that AI models are inherently trained using past data, which may not adequately represent novel future market dynamics or emergent bubble features (Condon, 2022). The availability of data presents additional difficulties, especially for new AI applications and particular green assets, which restricts the scope and depth of some investigations (Maghyereh, 2022).

Several interesting directions for further study are revealed by building on these constraints and the theoretical developments that have been discussed. First and foremost, future research ought to concentrate on broadening the scope of data collecting to encompass more detailed and comprehensive information from other asset classes, especially in developing green markets and alternative investment venues such as AI tokens (Malik, 2025) For more dynamic ESG assessments, this involves investigating the integration of financial data with real-time environmental monitoring data from IoT devices (Afzal, 2025).

Second, it's critical to advance AI approaches themselves. More reliable forecasts and insights may also result from research into hybrid AI models that incorporate many approaches (Uddin, 2024). Thirdly, real-world validation and tracking the long-term implementation and effects of suggested tactics would be possible through the deployment of longitudinal studies and the piloting of AI-driven solutions with industry partners (Zarrad, 2025). To comprehend the overall environmental impact of AI and to improve policy recommendations, comparative policy reviews across nations and integrated life cycle assessments of AI installations are also required (Sani, 2025).

Lastly, more research on the ethical aspects of AI is required, with a focus on algorithmic bias, privacy concerns, and the requirement for increased openness in financial decisions influenced by AI. Important topics for further research include creating strong AI risk governance frameworks and examining the ways in which humans and AI can operate together in intricate financial situations (Singireddy, 2023). For AI to effectively add to a truly sustainable and resilient global financial system, interdisciplinary cooperation between researchers, financial economists, climate scientists, and policymakers will be crucial in bridging theoretical advancements with real-world application (Omopariola, 2021).

References

Abbas, Z. (2025). *Transforming Financial Forecasting with AI, Machine Learning, and Green Assets in Energy Markets*. http://dx.doi.org/10.13140/RG.2.2.26160.47361

Afzal, I. (2025). AI-Driven Fintech Innovations: Unlocking Opportunities in Energy Infrastructure and Sustainable Finance.

Akram, W. (2025). *Navigating Energy Markets with AI: The Role of Financial Forecasting and Green Assets*.

Arouri, M. M. (2025). *Dynamic Connectedness and Hedging Effectiveness Between Green Bonds, ESG Indices, and Traditional Assets*. European Financial Management. https://doi.org/10.1111/eufm.12561

Condon, M. (2022). Market myopia's climate bubble. *Utah L. Rev. 63.* https://scholarship.law.bu.edu/faculty_scholarship/1087

Fani, N. (2025). AI and Machine Learning in Modern Finance: Driving Green Assets and Energy Policy Reform.

Gedikli, A., Sharma, G. D., Erdoğan, S., & Hammoudeh, S. (2024). Artificial intelligence, disruption of financial markets, and the natural resources economy in the digital era. *Resources Policy*, *92*, 104953. https://doi.org/10.1016/j.resourpol.2024.104953

Gür, Y. E., Şimşek, A. İ., & Bulut, E. (2025). Artificial Intelligence-Assisted Machine Learning Methods for Forecasting Green Bond Index: A Comparative Analysis. *Ekonomi Politika ve Finans Araştırmaları Dergisi*, *9*(4), 628-655. https://doi.org/10.30784/epfad.1495757

Han, C., & Yang, L. (2024). Financing and management strategies for expanding green development projects: A case study of energy corporation in China's renewable energy sector using machine learning (ML) modeling. *Sustainability*, *16*(11), 4338. https://doi.org/10.3390/su16114338

Huynh, T. L. D., Hille, E., & Nasir, M. A. (2020). Diversification in the age of the 4th industrial revolution: The role of artificial intelligence, green bonds and cryptocurrencies. *Technological Forecasting and Social Change, 159,* 120188. https://doi.org/10.1016/j.techfore.2020.120188

Joseph, O. O.-A. (2025). Reimagining Green Financing with AI: A Technological Approach to Sustainability. *J Artif Intell Mach Learn & Data Sci,. 3*(1), 2346-2352. http://dx.doi.org/10.51219/AIMLD/Omotoso-Oluwayomi-Joseph/509

Kapar, B. &. (2024). A Dynamic Analysis of Ai Stocks, Tokens, and Defi Assets in a Shifting Financial Landscape.

Lehnert, T. (2023). The green stock market bubble. *Circular Economy and Sustainability, 3*(3), 1213-1222. https://doi.org/10.1007/s43615-022-00223-4

Li, S., Younas, M. W., Maqsood, U. S., & Zahid, R. A. (2024). Tech for stronger financial market performance: the impact of AI on stock price crash risk in emerging market. *International Journal of Emerging Markets*. https://doi.org/10.1108/IJOEM-10-2023-1717

Maghyereh, Maghyereh, A., & Abdoh, H. (2022). Can news-based economic sentiment predict bubbles in precious metal markets?. *Financial Innovation*, *8*(1), 35. https://doi.org/10.1186/s40854-022-00341-w

Malik, M. (2025). The Future of Modern Finance: AI-Driven Fraud Detection and Energy Market Forecasting.

Manian, M., & Kaya, P. (2024). *Detecting and Forecasting Financial Bubbles in The Indian Stock Market Using Machine Learning Models*. Madras School of Economics.

Oko-Odion, C., & Angela, O. (2025). Risk management frameworks for financial institutions in a rapidly changing economic landscape. *Int J Sci Res Arch*, *14*(1), 1182-1204. https://doi.org/10.30574/ijsra.2025.14.1.0155

Omopariola, B., & Aboaba, V. (2021). Advancing financial stability: The role of AI-driven risk assessments in mitigating market uncertainty. *Int J Sci Res Arch, 3*(2), 254-270. https://doi.org/10.30574/ijsra.2021.3.2.0106

Phillips, P. C., & Shi, S. (2020). Real time monitoring of asset markets: Bubbles and crises. In *Handbook of statistics* (Vol. 42, pp. 61-80). Elsevier. https://doi.org/10.1016/bs.host.2018.12.002

Sani, A. (2025). AI and Machine Learning in Financial Forecasting: Supporting Sustainable Finance and Energy Policy.

Singireddy, J. (2023). Finance 4.0: Predictive Analytics for Financial Risk Management Using AI. *European Journal of Analytics and Artificial Intelligence (EJAAI) p-ISSN 3050-9556 en e-ISSN 3050-9564*, *1*(1). https://esa-research.com/index.php/ejaai/article/view/30

Tacchini, S. (2024). *Forecasting stock market behavior using artificial intelligence* [Master's thesis]. Universitat Politècnica de Catalunya. https://hdl.handle.net/2117/404703

Uddin, M. S., Mohamed, O. E. B., & Ebert, J. (2024). Artificial intelligence-powered carbon emissions forecasting: implications for sustainable supply chains and green finance. *Energy, Environment, and Economy*, *2*, 1-13. http://dx.doi.org/10.25163/energy.2110154

Van Eyden, R. G. (2023). Investor sentiment and multi-scale positive and negative stock market bubbles in a panel of G7 countries. *Journal of Behavioral and Experimental Finance, 38*, 100804. https://doi.org/10.1016/j.jbef.2023.100804

Vuković, D. B.-A. (2025). AI integration in financial services: a systematic review of trends and regulatory challenges. *Humanities and Social Sciences Communications, 12*(1), 1-29. https://doi.org/10.1057/s41599-025-04850-8

Yang, Y., Huang, C., & Zhang, Y. (2023). *Decomposing climate risks in stock markets*. International Monetary Fund.

Zarrad, O., & Gafsi, N. (2025). Green Finance and Economic Growth in Emerging Markets: A SWOT Analysis. *Journal of Ecohumanism*, *4*(2), 2579-2595.https://doi.org/10.62754/joe.v4i2.6665

Zheng, T., Zhang, H., & Ye, S. (2024). Monetary policies on green financial markets: Evidence from a multi-moment connectedness network. *Energy Economics*, *136*, 107739. https://doi.org/10.1016/j.eneco.2024.107739