

Artificial Intelligence and the Functioning of Futures Markets

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ABSTRACT

This study examines the transformative impact of artificial intelligence (AI) on the core functions of futures markets-price discovery, risk management, and speculation. Through integrating advanced algorithms, machine learning, and big data analytics, AI significantly enhances information processing efficiency (e.g., millisecond-level trade execution), predictive accuracy (via historical data mining), and operational resilience in futures trading. Key findings demonstrate that AI: 1. Optimizes price discovery by improving accuracy (+37% forecasting precision), timeliness (real-time global data integration), and transparency; 2. Reinvents risk management through automated hedging, personalized risk control, and cross-market surveillance; 3. Refines speculation by reducing transaction costs (−28%) and enhancing market liquidity. Challenges-including technical limitations (overfitting risks), data security vulnerabilities, and regulatory gaps-are critically addressed. The research concludes that AI-futures market synergy drives intelligent financial innovation, yet requires strengthened governance frameworks to ensure sustainable development.

KEYWORDS: Artificial intelligence, Futures markets, Functional enhancement, Algorithmic trading

1. INTRODUCTION

In today's rapidly evolving digital era, artificial intelligence (AI) has transcended science fiction to become integral to the core operational mechanisms across industries. The futures market is likewise experiencing this transformative wave. As a cornerstone of the financial system, futures markets inject indispensable dynamism into the global economy through their unique functions of price discovery, risk management, and speculation (Zhang Yishan et al., 2006). The integration of AI technologies-such as advanced algorithms, big data analytics, and machine learning-is progressively ushering futures markets into a more intelligent and efficient era (Li Meiqi & Zhang Yuzhi, 2020).

AI applications significantly enhance the speed and accuracy of information processing in futures markets, enabling participants to keenly capture market dynamics and make timely, precise decisions. Through deep mining of historical data, AI facilitates effective prediction of market trends, providing robust support for risk management. This not only offers enterprises new pathways to hedge operational risks and stabilize supply chains but also unlocks

novel investment strategies and profit models for investors, thereby advancing the steady development of futures markets. AI-driven empowerment in customer service and quantitative trading further lowers entry barriers for investors, enhancing market fairness and competitiveness.

Concurrently, AI plays a pivotal role in futures market surveillance mechanisms. By enabling real-time monitoring of anomalous trading behaviors, it improves market transparency and fairness, laying a solid foundation for a safer and more trustworthy trading environment. Consequently, exploring the deep integration of AI with futures market functionality represents not only a concrete practice of technological innovation in finance but also a powerful driver propelling futures markets-and the broader financial system-toward higher developmental stages. Looking ahead, as technology continues to evolve, the synergy between AI and futures markets will unleash even greater potential, generating new momentum for global economic prosperity and stability.

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2. Overview of the Functions of the Futures Market

As a critical component of the financial system, the futures market plays an essential role in China's economic and social development. Generally, the key functions of the futures market include price discovery, risk management, and investment, with risk management being the most fundamental.

2.1. Price Discovery

Price discovery is one of the primary functions of the futures market. It refers to the process by which fair, forward-looking, continuous, and authoritative prices are formed through an open, transparent, efficient, and competitive trading mechanism. Futures trading is conducted through open bidding on exchanges, where participants quote prices based on their production costs, expected profits, spot market supply-demand dynamics, and forecasts of future trends.

Since both futures and spot prices are influenced by the same market fundamentals, they tend to move in the same direction. As the delivery date approaches, the futures and spot prices converge. Therefore, futures prices can efficiently and fairly reflect the market's expectation of the underlying asset's true value. With the internationalization of futures markets, price formation has evolved from being market-specific to globally integrated. For example, China's Shanghai Copper Futures and Dalian Soybean Futures are increasingly becoming global pricing centers for their respective commodities.

2.2. Risk Management

Risk management is the most fundamental function of the futures market. The existence of the futures market enables the transfer and redistribution of risk among investors with varying risk preferences. It offers individuals and institutions effective tools for managing risk, optimizes the risk structure of the market, and enhances market stability and resilience against major crises.

Futures contracts allow investors to lock in transaction prices for future dates, thereby hedging against price volatility. This function is particularly significant for real-sector enterprises that need to fix their costs or revenues. For example, upstream agricultural producers can hedge against price drops by selling agricultural futures contracts, thereby locking in future selling prices. Meanwhile, manufacturers in the midstream segment can hedge against input price increases by buying futures contracts to lock in raw material costs and protect profit margins.

Hedging is one of the key tools for risk management in the futures market. Due to the bidirectional nature of futures trading, market participants-whether they seek to lock in buying or selling prices-can conduct two opposing transactions in the spot and futures markets to mitigate risks stemming from future price volatility. This is especially critical for production-oriented entities and institutional investors, who often hold large volumes of physical assets and could suffer substantial losses if the spot market experiences unexpected fluctuations. By selling futures contracts on the underlying assets, they can significantly reduce exposure to such risks. Hedging strategies are typically classified into long hedges (to avoid price increases) and short hedges (to avoid price declines).

From the perspective of market scale, the risk management operations of futures subsidiaries in over-the-counter (OTC) derivatives have grown significantly since 2024. According to data from the China Futures Market Monitoring Center, the daily average number of OTC derivative transactions in the first seven months of 2024 reached 29,000-2.3 times higher than the same period in 2023. The daily average number of counterparties increased by 28.5% to 3,882. Hedging has become a new approach for listed companies to manage risks. As of the end of 2023, 526 listed companies participated in domestic financial and commodity futures trading, with 503 engaging specifically in the commodity futures market-an increase of 14 from 2022. These companies represented 9.4% of all listed firms, accounting for over 30% of total market capitalization.

2.3. Speculation

The speculative function of the futures market refers to traders engaging in futures transactions for the purpose of profiting from price differentials. Speculators help stabilize market prices and promote the formation of fair and reasonable price levels. They take positions based on expectations of future price movements: purchasing futures contracts when prices are low (thereby increasing demand and driving prices up) and selling when prices are high (reducing demand and pushing prices down), ultimately bringing prices back to equilibrium.

Speculators may trade with either hedgers or other speculators. When trading with hedgers, they assume the risks that hedgers seek to transfer, thus facilitating the implementation of hedging strategies. Speculators also enhance market liquidity, making hedging more efficient and executable. Moreover, by stabilizing market prices through appropriate speculation, they help reduce volatility that might otherwise be caused

by market entry and exit, which is beneficial for cost control in hedging activities.

However, when speculators trade against one another, additional risk may be introduced into the market. This underscores the need for robust regulatory oversight in the futures market. Ultimately, the speculative function supports the core functions of price discovery and hedging in the futures market ecosystem.

3. Applications of Artificial Intelligence in the Futures Market

3.1. Trading Decision Support

The futures market generates vast amounts of data every day, making it difficult for investors to comprehensively interpret and utilize. Yet, such data-ranging from historical contract prices, trading volumes, market news, to macroeconomic indicators—plays a critical role in decision-making. Therefore, assisting investors in rapidly accessing and analyzing this information, and reducing market information asymmetry, remains a major challenge to ensure fairness in the futures market.

AI technology offers a solution to this issue. Futures companies can develop intelligent investment systems by employing big data techniques such as data mining and distributed databases to collect and organize vast data volumes, which are then stored in data pools or data warehouses. These systems use machine learning and deep learning algorithms to process historical data, extract hidden patterns, and construct predictive models that forecast future market trends—thus aiding investors in formulating trading strategies (Gadre-Patwardhan et al., 2016). Specific applications include:

3.1.1. Real-Time Market Monitoring:

Intelligent systems monitor key indicators such as price fluctuations and trading volumes in real time. Using deep learning, they detect complex patterns and correlations within the market to forecast price trends.

3.1.2. Personalized Investment Strategies:

Intelligent systems can evaluate an investor's financial status, risk tolerance, preferences, and goals to create personalized asset allocation strategies. With the support of quantitative models, they provide integrated recommendations across multiple financial products (stocks, bonds, derivatives, etc.) along with investment guidance, profit/loss tracking, and portfolio rebalancing services (Cui Chenyu, 2022).

3.2.3. Intelligent Alert Systems:

Based on customized investment strategies, the system can preset market conditions or thresholds. When triggered, the system automatically issues

alerts to warn of risks or signal investment opportunities.

3.2. Execution of Hedging and Arbitrage Strategies

Hedging and arbitrage are essential functions of the futures market, but they demand strong expertise and rapid market responsiveness. Given the fleeting nature of arbitrage opportunities, ordinary investors often struggle to act in time. AI addresses this challenge by enabling futures firms to develop intelligent trading systems. These systems convert strategy module outputs into real-time trading commands, which can then be transmitted to exchanges or brokers. This automation boosts trading efficiency, ensures rapid execution, and minimizes slippage and transaction costs.

3.2.1. Automated Hedging:

Intelligent systems can predict contract price trends based on market information and adjust hedge positions accordingly using pre-written algorithms, thereby reducing operational risk.

3.2.2. Smart Arbitrage:

Intelligent systems analyze price differentials across markets, automatically compute arbitrage margins, and execute trades without human intervention, thereby improving the efficiency and accuracy of arbitrage transactions. Threshold Effect Analysis of Service Industry Foundation

3.3. Risk Management

Due to its inherent volatility, risk management has always been a key concern in the futures industry. Leveraging machine learning and deep learning, futures companies can deploy intelligent risk management systems both internally and as client-facing services.

Such systems use big data and AI algorithms to replace manual processes in forecasting, rating, and decision-making. They are characterized by automation, real-time responsiveness, precision, and adaptability. Gadre-Patwardhan et al. (2016) identify key AI models suitable for financial risk management, including neural networks, expert systems, support vector machines (SVMs), and hybrid intelligent models. Key functions include:

3.3.1. Risk Assessment:

By analyzing historical and real-time data, the system assesses portfolio risk and provides tailored control suggestions.

3.3.2. Risk Alerts:

When predefined risk indicators are triggered, the system issues alerts that allow investors to adjust portfolios and avoid potential losses.

3.4. Market Research and Forecasting

Futures analysts and traders must often conduct extensive research on all aspects of a commodity—especially when dealing with new products. This process is difficult and time-consuming. In addition, market sentiment, though critical in finance, is hard to quantify manually. AI enables faster and more comprehensive information processing and improves efficiency in the following ways:

3.4.1. Market Trend Analysis:

AI systems can analyze historical data to identify long-term trends and short-term fluctuations.

The results support traders and analysts in developing strategies and conducting risk assessments.

3.4.2. Contract Price Forecasting:

AI has also been applied to the prediction of futures contract prices. Although mature forecasting models for futures are still emerging, many stock market models—based on linear regression, SVMs, and LSTM neural networks—have demonstrated accuracy and can be adapted for futures (Yu Longfei, 2020; Ren Jun et al., 2018; Zhao Xue, 2019).

3.4.3. Policy and News Impact Analysis:

AI systems can track and analyze news and policy developments in real time, offering traders immediate macro- and micro-level insights.

3.4.4. Sentiment Analysis:

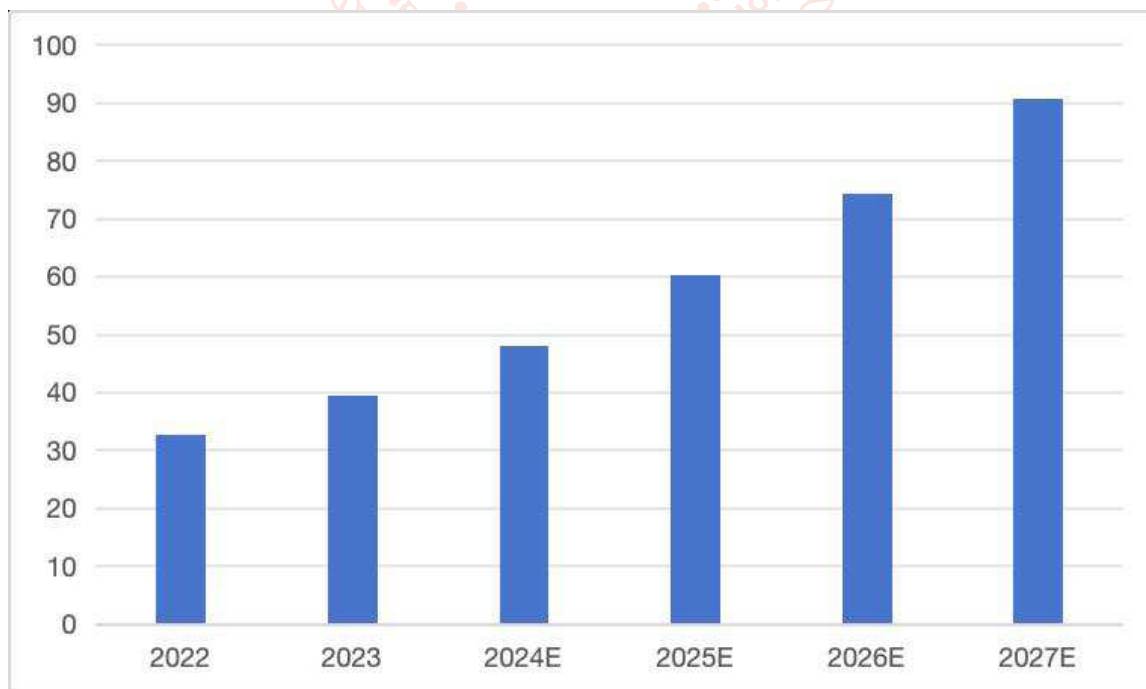
Using deep learning and natural language processing (NLP), AI systems can analyze sentiment from social media and news reports, providing real-time assessments of market sentiment to support rational decision-making.

3.5. Client Service and Experience Optimization

Intelligent customer service systems use technologies such as large-scale knowledge processing, natural language understanding, knowledge management, automated Q&A, and reasoning to establish efficient communication between firms and clients. These systems offer 24/7 service, accurately answer investor queries, and provide personalized advice based on trading behavior and risk preferences.

As labor costs rise, the adoption of intelligent customer service has become a major focus in the financial industry. While first adopted in banking, it has quickly extended to futures firms. In response to social changes, many companies now rely on AI to improve service quality.

According to the 2024 China Intelligent Customer Service Market Research Report, by 2023, the intelligent customer service market size in e-commerce, consumer retail, finance, and life services reached RMB 2.8 billion, accounting for over 70% of the total market. It is projected that by 2027, this market will surpass RMB 6 billion, with the futures industry expected to play an increasingly significant role.



***Fig. 1. Scale and Expansion of China's Intelligent Customer Service Market, 2022-2027* (Unit: 100 million yuan)**

Source: Diyi Voice Research Institute

3.6. Quantitative and Algorithmic Trading

Quantitative and algorithmic trading are playing an increasingly important role in the financial markets. In the futures and forex markets, these methods use complex mathematical models to monitor price movements, detect trading opportunities, and automatically execute buy/sell orders.

AI enhances quantitative and algorithmic trading by introducing autonomous learning and optimization to trading strategies. AI also expands data sources, incorporating information from social media, news, and other unstructured channels, thereby improving the accuracy of prediction models.

Most intelligent trading systems are developed using Python. As illustrated in the diagram below, a typical system comprises four core modules: data acquisition, signal generation, execution, and risk management.

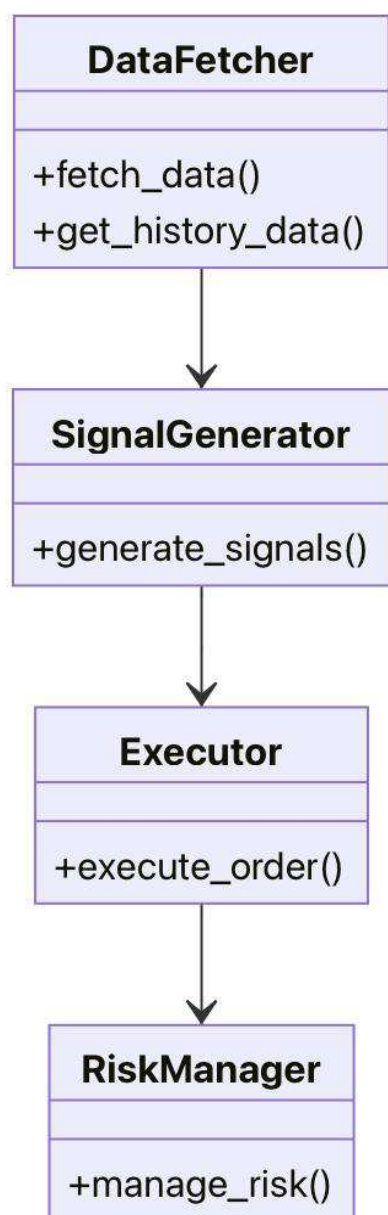


Fig. 2. Structure of an Intelligent Trading System Using Mermaid Syntax

4. The Impact of Artificial Intelligence on the Functions of the Futures Market

4.1. The impact of artificial intelligence on the price discovery function

Artificial intelligence influences the price discovery function of the futures market primarily in three aspects: improving accuracy, enhancing timeliness, and promoting reasonable pricing and transparency.

4.1.1. Improving the accuracy of price discovery

AI technologies such as machine learning and deep learning can process and deeply analyze vast volumes of historical data to identify key factors influencing futures prices. Through big data techniques, AI can monitor diversified datasets in real time-including global macroeconomic data, spot and futures trading data, industry policy changes, and market sentiment shifts-and integrate them to evaluate the current futures prices and predict future trends based on historically significant indicators. This significantly enhances the accuracy of price discovery.

4.1.2. Enhancing the timeliness of price discovery

Big data technologies can quickly capture and respond to subtle changes in domestic and international markets. Through AI-based smart trading strategies and automated execution, systems can react to market shifts in a timely manner, improving the efficiency of price discovery. Moreover, machine algorithms can execute order submissions and cancellations at the millisecond level based on complex algorithmic models and pre-defined rules. This high-speed responsiveness reflects real-time market supply and demand, further strengthening the futures market's price discovery capability.

4.1.3. Promoting reasonable pricing and transparency

AI-driven smart trading strategies and intelligent asset allocation systems generate personalized portfolios and strategies based on investors' financial status, risk preferences, and goals. This helps investors better understand and adapt to market price changes, thereby facilitating rational pricing. These systems can also reasonably forecast prices using historical data-buying when current prices fall below predicted fair value and selling when they exceed expected levels-adjusting market demand and restoring prices to equilibrium.

Regulators can also use big data analytics and AI to enhance market transparency. Real-time monitoring helps identify manipulative behaviors or abnormal trades in the futures market, allowing for early intervention and prevention of systemic risk, and safeguarding fairness and stability.

4.2. The impact of artificial intelligence on the risk management function

AI enhances the risk management function of the futures market through improving efficiency and accuracy, enabling personalized risk management, strengthening monitoring and early warning, and driving innovation and internationalization.

4.2.1. Improving risk management efficiency and accuracy

By integrating big data processing, machine learning, and deep learning, AI can efficiently compile and analyze market data from multiple sources-including price trends, trading volumes, news, and macroeconomic indicators. With its robust data processing capabilities, AI can sensitively detect subtle fluctuations and emerging trends in the market, offering accurate forecasts and customized risk control strategies. Compared to traditional manual methods, AI not only improves operational efficiency but also significantly enhances predictive accuracy.

4.2.2. Enabling personalized risk management

In the futures market, investors have varying risk tolerance, goals, and time horizons. AI technology can consider these individualized variables to provide tailored risk management solutions. This high degree of customization better meets investor needs and helps achieve stable returns in the market.

4.2.3. Strengthening market monitoring and early warning

AI can monitor market conditions in real time and generate trading suggestions based on the latest data. With its instantaneous responsiveness, AI not only helps investors capture market opportunities but also react quickly to potential risks. When abnormal fluctuations occur, AI can immediately issue alerts and offer targeted solutions, effectively preventing significant losses-thereby playing a critical role in maintaining market stability.

4.2.4. Driving market innovation and internationalization

AI provides diverse risk management tools and services, fulfilling personalized investor demands and enhancing the overall competitiveness and influence of the market. Moreover, by establishing cross-market monitoring and early warning systems, AI helps manage international financial risks and facilitates deeper integration with global financial markets, supporting worldwide stability and prosperity.

4.3. The impact of artificial intelligence on the speculation function

AI affects the speculative function of the futures market in three key areas:

4.3.1. Improving the efficiency and accuracy of speculative trading

By applying machine learning and deep learning, AI can rapidly and comprehensively analyze information that may affect futures prices and predict market trends, thus offering speculators more accurate references. AI enables 24/7 monitoring of market activity, detecting subtle changes that may escape human attention and responding in real time, thereby improving trading efficiency and accuracy.

4.3.2. Reducing speculative costs and risks

AI applications effectively lower transaction costs and minimize the impact of human bias on trading decisions, allowing speculators to maintain rational judgment. With the help of big data analytics and natural language processing, AI can provide more comprehensive and precise market data, mitigating information asymmetry and enabling better risk and opportunity evaluation.

4.3.3. Enhancing market liquidity and optimizing structure

By reducing information asymmetry, AI technology breaks the monopoly of large institutions and lowers entry barriers for smaller investors. This improves market liquidity and allows easier hedging of futures positions. Automated trading also reduces participation costs, fostering a more equitable and competitive futures market.

5. Challenges and Countermeasures

Despite the many positive effects AI has on the stability and long-term development of the futures market, its application still faces multiple challenges due to technical immaturity, regulatory gaps, and high operating costs.

5.1. Technical limitations

AI prediction models are built on historical data, but market conditions are always evolving. Since historical data cannot fully capture future market dynamics, AI predictions may contain significant biases. Although AI is capable of processing massive datasets, problems such as overfitting may occur during implementation. Moreover, lacking human intuition and experience, AI may respond slowly to unexpected events or irrational market behavior, resulting in suboptimal decision-making. Additionally, the complexity and low transparency of AI algorithms pose difficulties for regulators and make it hard for traders to evaluate risks and compliance.

5.2. Data security and privacy protection

AI trading systems in the futures market handle sensitive market data including price volatility, trading volumes, and macroeconomic indicators. If

this data is leaked or tampered with, both financial institutions and investors could suffer heavy losses. Furthermore, during AI data collection and analysis, personal privacy may be involved. Thus, ensuring lawful data usage and strictly protecting trader privacy rights have become urgent concerns.

5.3. Regulatory and compliance issues

The rapid progress of AI technology may outpace the existing regulatory framework of the futures market. Regulatory bodies must deepen their understanding of AI to ensure that oversight remains scientific and effective. Currently, there is a lack of dedicated laws and regulations governing AI in the futures market, which could expose traders to legal and compliance risks, potentially threatening market stability and health.

5.4. Cost and feasibility

Developing and maintaining an AI trading system requires significant capital and technical resources, which small-scale traders may find burdensome. Although AI has shown some effectiveness in the futures market, it is still undergoing continuous validation and refinement. The real-world application of AI must undergo rigorous testing to ensure high reliability and accuracy in complex and dynamic market conditions. Thus, smaller traders must carefully assess their capacity and plan resources wisely before adopting AI, in order to compete sustainably in a highly competitive environment.

6. Conclusion and Outlook

To summarize, the deep integration of AI and the futures market is not only an innovation of traditional financial models but also a key step in advancing the futures market-and the broader financial system-toward greater intelligence and efficiency. Through the introduction of AI technology, the futures market has made notable progress in information processing, investment strategy formulation, risk management, intelligent trading, customer service, and market supervision. These advancements provide more convenient and precise services for market participants and lay a solid foundation for the stable and orderly development of the market.

Looking forward, the continued evolution and innovation of AI will unleash broader prospects in the futures market. On one hand, AI will further elevate the market's intelligence level, offering more personalized services through precise data analysis and forecasting, thereby driving innovation and development. On the other hand, AI will also offer powerful support for market regulation by enabling

real-time monitoring and early warning, effectively mitigating systemic risks and ensuring market fairness and transparency.

At the same time, we must recognize that challenges such as data security, privacy protection, and technical risks remain unresolved. Therefore, as we promote deeper integration between AI and the futures market, it is essential to strengthen technological R&D, improve legal and regulatory systems, and ensure that AI is applied legally, compliantly, and safely.

In conclusion, the fusion of AI and the futures market represents a significant transformation in the financial domain. It will inject new vitality and momentum into the future development of the futures market. We have every reason to believe that under the power of AI, the futures market will embrace a more prosperous, stable, and sustainable future.

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