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The Impact of Financial Derivatives on Liquidity, Volatility, and Regulatory Challenges in China's Stock Market

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Abstract. The growing use of derivatives, including stock index futures and ETF options, has heightened focus on their effects in China's stock market. Thus, this study investigates the impacts of derivatives on China's stock market across five dimensions: market liquidity, pricing efficiency, volatility, investor structure, as well as regulatory challenges. Based on existing literature, relevant cases, and market data on China's derivatives and quantitative trading, the study focuses on the application and impact of stock index futures, ETF options, and quantitative strategies, while employing tools such as statistical arbitrage and implied volatility to evaluate price discovery efficiency, and using high-frequency trading data and institutional investor holdings to analyze market volatility and changes in investor structure. The results show that derivatives enhance market liquidity via risk hedging and speculative opportunities and boost price discovery through statistical arbitrage and implied volatility, aligning stock prices with fundamentals. Under some conditions, they can amplify volatility, cause herding in similar quantitative strategies, and raise systemic risk with leverage and HFT. Besides, broad participation by derivatives and institutional investors drives market institutionalization, enhancing stability and efficiency, while posing regulatory challenges such as manipulation, data fairness, and leverage risks. As such, China has addressed these via intelligent surveillance, classified data management, and leverage stress testing, thereny maintaining market stability while supporting innovation.

Keywords: Chinese stock market, Financial derivatives, Market liquidity, Market volatility, Quantitative trading

1. Introduction

In recent years, derivatives such as stock index futures and ETF options have become an important component of China's quantitative finance sector. In practice, these derivatives provide institutional investors with risk management and hedging tools while simultaneously enhancing stock market liquidity and pricing efficiency via speculative opportunities and strategies like statistical arbitrage [1]. Existing studies has primarily examined the impact of derivatives in isolated aspects, such as liquidity or pricing efficiency, while thorough evaluations of their broader, multidimensional effects are still lacking [2]. While derivatives boost market efficiency, they can increase volatility through high-frequency trading and herd behavior, shift the investor base toward institutional dominance, and create regulatory concerns, including data fairness and leverage oversight, which offer valuable

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opportunities for future study. This study analyzes the multidimensional impacts of derivatives on China's stock market, examining their effects on market liquidity, pricing efficiency, volatility, and investor structure, while assessing the regulatory issues arising from the development of derivatives. By reviewing relevant literature and case studies, it investigates the applications and influences of derivatives in China's stock market, evaluates their role in enhancing market professionalism and institutional influence, and proposes regulatory measures such as monitoring high-frequency trading, ensuring data transparency, and managing leverage. Accordingly, the study helps to understand the role of derivatives in liquidity, pricing efficiency, volatility, and investor structure, while guiding investors and regulators in managing risks and shaping strategies.

2. The impact of derivatives on liquidity and pricing efficiency in China's stock market

2.1. The impact of derivatives on market liquidity

Through their risk-hedging and trading facilitation functions, derivatives support market liquidity. In particular, market downturns can be hedged by institutional investors using stock index futures, a core instrument. During market adjustment in China caused by policy changes or macroeconomic volatility, like the 2023 short-term A-share correction, institutions could hedge large-cap portfolio losses through stock index futures, thus maintaining portfolio stability and dampening panic-driven market effects [3]. Similarly, the application of stock index futures alleviated one-sided downward pressure during the capital outflow cycle triggered by the United States Federal Reserve (the Fed)'s interest rate hikes in 2022, maintaining trading order and providing speculative opportunities based on market direction, which contributed to relatively stable trading volume [4].

Moreover, ETF options, with their flexible trading and risk hedging capabilities, improve market liquidity. Thus, investors can participate in sectoral gains through call options or limit losses during declines, enhancing trading efficiency amid sector rotation or industry adjustments [5]. In addition, non-directional trading strategies, such as straddle option positions, provide trading opportunities during periods of market turbulence, increasing overall market activity [6]. Besides, the presence of ETF options narrows the bid-ask spread of the underlying ETFs, further boosting liquidity. For instance, the introduction of CSI 300 ETF options led to an around 30% increase in the underlying ETF's average daily trading volume and a nearly 20% reduction in its bid-ask spread. As such, both stock index futures and ETF options boost market liquidity via risk hedging and trading flexibility.

2.2. The impact of derivatives on market pricing efficiency

Through arbitrage mechanisms and market sentiment signals, derivatives enhance the efficiency of price discovery. Specifically, profits from statistical arbitrage are generated by exploiting short-term price anomalies rather than following market trends, while simultaneously correcting prices toward their fundamental levels [7]. In China's market, ETF arbitrage is a common approach. For instance, when temporary divergences occur between the CSI 50 ETF and CSI 300 ETF, quantitative models can rapidly buy undervalued assets and sell overvalued ones to capture profits. In recent years, this strategy has effectively corrected significant price deviations in the CSI 300 constituent stocks, improving market pricing efficiency and bringing stock prices closer to their fundamental values [8]. As a result, statistical arbitrage plays a significant role in correcting price deviations.

Additionally, implied volatility is used as a market sentiment indicator, supporting quantitative pricing and price forecasting [9]. The HVIX index reflects market expectations of future volatility. For example, HVIX surged to 63.5 during periods of extreme market stress, thus reflecting panic,

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whereas in 2023 it remained in the 15~20 range, corresponding to a 12% gain in the CSI 300 Index and suggesting stable market sentiment. Meanwhile, domestic implied volatility has shown a strong correlation with subsequent realized volatility, indicating that implied volatility effectively reflects market expectations and contributes to pricing accuracy [10]. Furthermore, incorporating implied volatility with macroeconomic data allows for the pre-adjustment of target prices for overvalued stocks, improving pricing accuracy. In 2023, models including this factor cut the price prediction error for CSI 300 constituent stocks by 28% compared to previous models. Both statistical arbitrage and implied volatility mechanisms enhance market pricing efficiency by correcting price deviations and reflecting market sentiment, bringing stock prices closer to their fundamental values.

3. The impact of derivatives on volatility and investor structure in China's stock market

3.1. The impact of derivatives on market volatility

Though derivatives and quantitative strategies enhance market liquidity, they may amplify volatility under specific conditions. Firstly, high-frequency trading (HFT) in China is influenced by the T+1 settlement rule, with a risk transmission mechanism that differs from those in mature markets [11]. In China, HFT primarily leverages liquidity-providing and spot-futures arbitrage algorithms, which account for about 25% of daily liquidity during calm market periods [12]. However, under market stress, the T+1 rule forces high-frequency traders to liquidate positions within a limited timeframe, amplifying price fluctuations. Past events in China's stock market show that high-frequency trading and technical disruptions can trigger rapid order executions and sudden surges in trading volume, causing sharp short-term price fluctuations and amplifying market volatility. Under the T+1 rule, these cases demonstrate that HFT's speed advantage can boost volatility in crises.

Secondly, the "herding behavior" of quantitative strategies further exacerbates market volatility. When most institutions adopt similar momentum or volatility factor models, abnormal signals can trigger synchronized trades, creating concentrated buying or selling pressure [13]. For instance, at the beginning of 2020, quantitative models triggered position reductions, and within two hours, quantitative funds sold over RMB 20 billion in stocks, causing sharp declines in the consumer and tourism sectors. This pattern repeated during the quantitative redemption wave in September 2021, indicating that uniform quant strategies boost volatility in extreme conditions.

Thirdly, regulatory measures aim to balance innovation and risk. For HFT, current regulations limit the size of single trades and frequent order cancellations, while HFT submission systems are tested for real-time monitoring [14]. For quantitative strategies, regulators promote diversified modeling that integrates macroeconomic and industry policies, instead of depending exclusively on momentum or volatility factors. Thus, derivatives and quantitative strategies have a dual impact on market volatility: they enhance liquidity during stable periods but require regulatory intervention under extreme conditions to prevent amplified fluctuations.

3.2. The impact of derivatives on investor structure

The participation of derivatives and institutional investors is reshaping the investor structure in China's stock market, enhancing both market stability and efficiency. Firstly, retail and institutional investors differ markedly in trading styles and the use of derivatives. Retail investors tend to follow sentiment-driven, short-term trends and are prone to chasing gains and selling during downturns, whereas institutions, particularly quantitative funds, rely on data and models to execute more stable strategies [15]. In derivatives trading, institutions more frequently use instruments to hedge risk, like

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options to offset sector declines, while retail investors' use remains limited. These differences directly affect market stability: retail-dominated stocks exhibit larger volatility and slower rebounds, whereas institutional holdings tend to align more closely with fundamental values.

Secondly, the market shows a clear trend toward institutionalization. In recent years, the share of institutional investors in both market capitalization and trading volume has increased significantly [16]. Capital flows indicate that institutions favor high-dividend blue chips and technology growth stocks, while net selling occurs in small-cap stocks preferred by retail investors. In the derivatives market, institutions dominate hedging positions in stock index futures and ETF options. Moreover, the issuance of products favored by institutions has risen, while those preferred by retail investors have declined. These trends suggest a gradual shift toward institutionalization, with retail investor behavior increasingly aligning with institutional patterns.

Thirdly, institutionalization brings positive effects, as markets become increasingly logic-driven and standardized, with improved information disclosure and transparency [17]. The "Institutional Derivatives Trading Reporting System," introduced in 2024, requires institutions to disclose trading objectives and risk exposures, improving market fairness. In the long term, sustained institutional participation and the diversification of derivatives tools are expected to improve market stability and efficiency, bring China's stock market closer to mature market standards, attract foreign capital, and integrate it more fully into the global financial system.

4. The impact of derivatives on regulatory challenges in China's stock market

4.1. Market manipulation risk control

The use of derivatives and HFT can lead to market manipulation, thereby threatening fairness and stability [18]. To mitigate this risk, the China Securities Regulatory Commission has implemented an intelligent regulatory system that monitors HFT across the entire trading process. The system can track every step of an order, from submission to execution, including millisecond-level operations. Monitoring focuses primarily on cancellation and execution rates. If an account cancels more than 80% of orders within 100 milliseconds of submission, or if large orders remain unexecuted for extended periods, the system flags these as anomalies. Using machine learning models, the system can distinguish between legitimate arbitrage and malicious manipulation. In 2024, the upgraded model was trained on a five-year dataset to detect concentrated and targeted order activities and to monitor arbitrage or manipulative behavior across stocks, futures, and options markets.

For example, the effectiveness of the intelligent regulatory system is demonstrated by prominent manipulation cases. In 2022, a group of traders used 12 linked accounts to place 12,000 fictitious buy orders for technology stocks within ten minutes, canceling at price peaks. The China Securities Regulatory Commission detected the irregular activity the same day and imposed penalties. In 2023, a firm used algorithms to suppress ETF option prices. The regulatory system flagged the activity by analyzing deviations in price and trading volume and executed corrective actions. These cases show that the system can identify and address manipulative trading behaviors in real time. Meanwhile, the design of the intelligent regulatory system can draw on international practices. For example, HFT submission systems oblige institutions to disclose algorithmic frameworks, risk mitigation strategies, and anomaly-handling protocols. To reduce manipulation risks, the system delays large HFT order reports, tracks activities affecting retail investors, and allows safe testing of new strategies.

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4.2. Data transparency and fairness protection

The effectiveness of risk management and trading in quantitative strategies hinges on the quality, transparency, and fairness of the underlying data [19]. Therefore, the establishment of a robust data regulatory framework is crucial for the mitigation of potential risks. Regulators apply classified data management, separating public and private data. For public data, uniform dissemination ensures that all market participants receive information simultaneously, thus preventing trading advantages caused by information asymmetry. For private data, registration and anonymization are required, and usage is tracked through digital watermarking to prevent misuse or leaks, thereby protecting commercial secrets while maintaining market fairness.

Regarding data quality, regulators have set clear standards encompassing accuracy, timeliness, and verifiability. Specifically, accuracy requires that market participants' data closely match source data; for example, historical stock prices must align with exchange records within minimal error margins, and economic indicators should be sourced from official releases. In terms of timeliness, real-time market data must be transmitted to trading systems immediately after release to ensure decisions are based on the most current information. As for verifiability, it ensures that different institutions obtain consistent results when applying the same methodology, preventing strategy misjudgments or market distortions due to data quality issues. Collectively, high-quality and fair data not only ensure the reliability of quantitative strategies but optimize market resource allocation. Moreover, by reducing information asymmetry, a transparent data environment allows small and medium-sized institutions and retail investors to compete under fairer conditions. Such regulatory arrangements enhance price discovery efficiency and market liquidity, strengthen market resilience and stability, and provide investors with a predictable trading environment and a sound basis for decision-making.

4.3. Leverage risk in quantitative strategies

In quantitative strategies and structured products, leverage is widely used, amplifying both returns and losses, and thus posing risks to market stability under extreme conditions [20]. The leverage effect means that even minor price fluctuations can trigger significant losses or forced liquidations. When highly leveraged institutions are compelled to sell assets simultaneously, the pressure quickly spreads to related stocks and derivatives, prompting other institutions to adjust their positions in tandem and further amplifying overall market volatility. If coupled with high-frequency trading, the process can trigger sharp short-term price swings and elevate systemic risk.

To address these risks, both institutions and regulators have established multi-layered safeguards. At the institutional level, institutions generally establish stop-loss limits, adjust leverage ratios in real time, and diversify portfolios to curb exposure to individual markets. At the regulatory level, stress testing and real-time monitoring are employed to identify and contain risks. Industry-wide stress tests model extreme conditions to measure potential losses and may obligate highly leveraged institutions to scale back leverage or inject additional capital. Real-time monitoring platforms trigger interventions during abnormal volatility, hence preventing the buildup and spread of risks. Furthermore, transparency in leverage usage has been strengthened, with institutions required to report leverage data in real time to facilitate the early detection of potential vulnerabilities.

In the long run, an institutionalized framework for leverage risk management helps prevent systemic shocks and enhances the stability and predictability of market operations. By reinforcing investor confidence, it provides essential safeguards for the sustainable development of derivatives and quantitative trading.

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5. Conclusion

This study addresses the core research question of how derivatives influence China's stock market across five dimensions, with key findings showing their dual effects. From one perspective, stock index futures and ETF options provide hedging and speculative channels that boost market liquidity and pricing efficiency, while high-frequency trading and quantitative strategies improve market efficiency under typical conditions. Conversely, derivatives can amplify volatility under stress, with highly homogeneous quantitative models triggering herd behavior and leverage interacting with HFT to increase systemic risk. Meanwhile, the trend toward institutionalization has become more pronounced, with institutional investors reinforcing logic-driven pricing while also placing higher demands on regulatory oversight. From a regulatory standpoint, risk management in China has been reinforced via the implementation of intelligent surveillance systems, classified data governance, and leverage stress testing. These measures support both innovation and stability while providing a foundation for the long-term development of derivatives markets. Nonetheless, limitations remain, including the lack of quantitative evaluation of derivatives' effects and restricted consideration of cross-border linkages. Future research could employ long-term datasets and empirical models to examine the cyclical effects of derivatives and explore the application of emerging technologies such as artificial intelligence in market supervision.

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