Beyond the Boundaries of Rationality: Evidence from Risk Management Reconstruction of the USA Future Markets

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Abstract: As a powerful supplement to traditional finance, behavioural finance emphasizes the essential role of investors' irrational behaviour and market psychology in market price fluctuations. This article summarizes the application of behavioural finance in risk management in the US futures market, especially the practical application and theoretical discussion of the futures market in flash crashes, margin calls caused by EMH failure, and position limits. This research teases out the latest progress in these research fields, proposes the necessity of introducing behavioural finance perspectives into risk management, and summarizes the main research hotspots in this field, including investor sentiment, market manipulation, and irrational factors of market efficiency. Based on comprehensive analysis, this paper further proposes the direction of optimizing risk management methods in the future, especially in the context of using emerging technologies such as artificial intelligence and big data, how behavioural finance can promote the reconstruction of the risk management paradigm in the futures market.

1 INTRODUCTION

In recent years, the futures market has experienced many volatile events, such as the 2008 financial crisis, the flash crash in May 2010, and the Archegos liquidation in 2021.These events show that traditional risk management methods according to rational investor hypothesis exist flaws (Borowiecki et al., 2023). In addition, the behavioural finance challenges the “rational person assumption”, which supposes investors are often affected by psychological biases, emotional fluctuations and other factors, causing market prices to deviate from their intrinsic value. This theory provides theoretical support for irrational behaviour in financial markets, especially in futures markets, where investors’ emotions and decision-making behaviours have an increasingly significant impact on market fluctuation (Tversky & Kahneman, 1979; Geboers et al., 2023). As one of the world's largest and most liquid derivatives markets, the stability of the U.S. futures market directly affects the security of the global financial system.

Recently, the extreme volatility and frequent flash crashes in the market have exposed the limitations of traditional risk management methods. Especially, when EMH fails, traditional quantitative models and risk management strategies fail to effectively respond to market crashes and leverage liquidations. The rise of behavioural finance provides a new perspective for solving this problem. By understanding investors' psychological biases, irrational decision-making behaviours and fluctuations in market sentiment, it can provide more effective solutions for market risk control. Moreover, with the rise of high-frequency trading and algorithmic trading, flash crashes in the futures market have occurred frequently. These events usually occur in a very short period of time, causing market prices to fluctuate violently and have serious consequences. The explanation of flash crashes by investor sentiment and market reactions from the perspective of behavioural finance has become one of the current research hotspots (Tian et al., 2025). In addition，The failure of the efficient market hypothesis has made systemic risks and margin calls in the futures market more prominent. Behavioural finance has proposed a new risk management framework by explaining the irrational behaviour of investors, especially how to effectively manage market crash risks and leverage margin calls when EMH fails (Cheng & Wang, 2022). Last but not least, as a market risk control tool, the position limit system has been widely used in the futures market. Studies have shown that reasonable position limits

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can effectively curb market manipulation and excessive speculation, but overly strict position limits may affect market liquidity. Therefore, how to balance risk control and market efficiency has become an important issue in current research (Zhou, 2020).

The main object of this study is the U.S. futures market, especially how behavioural finance is applied to risk management in situations such as financial crises, flash crashes, leveraged trading, and position restrictions. This paper aims to review the application of behavioural finance in risk management in the U.S. futures market, systematically summarize existing research results, analyse its shortcomings, and propose future research directions. The paper is arranged as follows: the first part reviews the flash crash phenomenon in the futures market and its behavioural finance explanation; the second part discusses the risk management of liquidation when EMH fails, and analyses the risk control strategy from the perspective of behavioural finance; the third part discusses the theoretical basis and practice of position limits, and analyses its impact on market stability and liquidity; the last part summarizes the whole paper and proposes the potential application and development direction of behavioural finance in futures market risk management.

2 FLASH CRASH PHENOMENON AND MARKET RISKS

A flash crash is a violent price swing in a financial market that occurs in a very short period of time, usually accompanied by a brief collapse of the market, followed by a rapid recovery in prices. This phenomenon is different from general market fluctuations, and is specialized by the extreme nature of the speed and magnitude of the fluctuations. Triggers are often not triggered by macroeconomic data or fundamental factors, but by changes in the market microstructure, feedback effects of trading behavior, or technical factors. Compared with general market volatility, flash crashes have the following significant differences: the first is the time scale: flash crashes usually occur in a very short period of time, while general market volatility can last for hours, days, or longer; The second is volatility: flash crashes are accompanied by violent price fluctuations, which can lose tens of percentage points in a matter of minutes, while general market volatility is usually relatively flat; The third is regression: flash crash events are usually short-lived, and prices may quickly rebound and return to normal levels after a rapid decline, showing extremely high short-term market uncertainty. These characteristics suggest that flash crashes are not only price fluctuations in the market, but also reflect the interaction of market structure, investor behaviour, and trading technology under extreme conditions.

High-Frequency Trading and Algorithmic Trading are widely considered to be crucial catalysts for flash crashes. In modern financial markets, high-frequency trading algorithms execute transactions within microseconds through automated programs. These algorithms quickly drive market price fluctuations through technical trading rules and market liquidity arbitrage (Tian et al., 2025), then the flash crash phenomenon occurs. Specifically, algorithmic trading promotes flash crashes through the following mechanisms:

- Weakened market liquidity. Under normal market conditions, algorithmic trading can provide liquidity, but when the market fluctuates violently, trading algorithms may suspend trading or withdraw orders, which leads to a sharp drop in market liquidity and further exacerbates the violent price fluctuations (Geboers et al., 2023).
- Feedback mechanism. Algorithmic trading usually responds to changes in market prices. When prices fall rapidly, algorithms may automatically trigger sell orders, forming an "avalanche effect" and exacerbating further price declines (Sun & Li, 2022).
- Market chain reaction. When a flash crash occurs, the reactions of algorithms are often not isolated, and they will affect each other, thereby accelerating the process of market collapse.

In March 2023, Silicon Valley Bank suffered a liquidity because of asset-liability management errors, which triggered a large-scale deposit run and eventually led to its bankruptcy. Although this event originated in the banking system, its impact quickly spread to the futures market and other financial derivatives markets. The panic in the market caused violent fluctuations in futures contracts, especially in financial derivatives and high-risk assets related to Silicon Valley Bank, and the prices of futures contracts plummeted. The flash crash characteristics of this event are manifested as extreme price fluctuations and loss of market confidence. Within minutes of Silicon Valley Bank's bankruptcy announcement, the prices of related assets in the futures market (e.g., bank stock futures, bond futures) fell sharply. Although there was a certain rebound afterwards, the prices failed to quickly return to the level before the crash (Song et al., 2023). Secondly, the drastic change in investor sentiment caused the futures market to panic, and many funds quickly withdrew from related assets, forming a typical flash crash phenomenon (Gärling et al., 2021).

Behavioural finance provides important psychological and market sentiment explanations for the flash crash phenomenon. Compared with traditional rational economic theory, behavioural finance emphasizes the irrational behaviour of investors in the face of uncertainty, and how this behaviour affects market price fluctuations. Specifically, behavioural finance's explanation of flash crashes can be expanded from the following aspects:

- Driven by cognitive bias. Investors tend to overreact when faced with sudden information, and emotional decisions cause prices to deviate from fundamentals (Tversky & Kahneman, 1979). The herd effect induced by panic will accelerate the spread of selling behaviour, such as the contagious spread of market panic in the Silicon Valley Bank incident in 2023 (Tian et al., 2025).
- Market mechanism amplification. The sudden drop in liquidity resonates with the withdrawal of high-frequency trading, and the lack of market-making mechanism exacerbates price fluctuations (Geboers et al., 2023). Feedback trading forms a vicious cycle of price decline-sell-off reinforcement, and the Archegos liquidation incident shows this self-reinforcing market effect (Sun & Li, 2022).
- The flash crash phenomenon reveals the profound impact of irrational behaviour, market psychology and trading technology in the financial market on market volatility. Although high-frequency trading and algorithmic trading contribute to market liquidity under normal circumstances, they may also exacerbate price fluctuations and form flash crashes under extreme circumstances. Behavioural finance provides a powerful theoretical explanation for the flash crash phenomenon through factors such as investors' psychological biases, herd effects and feedback trading. Future market supervision and risk management strategies should fully consider these irrational factors to improve market stability and transparency.

3 EMH FAILURE AND MARGIN CALL RISK CONTROL

3.1 EMH Assumptions and Failure Cases in the Real Market

EMH proposes that market prices always fully reflect all information, so that investors cannot obtain excess returns through technical analysis or fundamental analysis. However, EMH is frequently challenged in the real market, especially in the context of financial crises and market crashes, when the market often shows obvious irrational behaviour and price inefficiency. The 2008 financial crisis is a classic example of the failure of EMH. The outbreak of the crisis stems from the bursting of the bubble in the US real estate market, especially in the context of the subprime mortgage crisis, when the excessive leverage and risky investment behaviour of financial institutions led to the market crash. The subprime mortgage crisis shows that the market does not effectively reflect risks and information as assumed by the EMH. On the contrary, due to speculative behaviour, overly optimistic expectations and excessive reliance on asset prices, market prices have deviated significantly from their actual values:

- Irrational decision-making of financial institutions. Before the crisis broke out, a large number of financial institutions ignored fundamental risks, engaged in high-leverage speculation, and relied on incorrect information assessment tools (such as credit ratings) to make decisions. The information was seriously lagging and incomplete, leading to systemic failure of the market (Frydman & Camerer, 2016).
- Overreaction and slowness of market reaction. In the early stage of market turmoil, investors overreacted, causing prices to plummet rapidly and the market to recover slowly, proving that the EMH theory fails in extreme situations (Chen et al., 2015).

3.2 Leveraged Trading and Liquidation Risk Management

Leveraged trading is a common strategy to amplify investment returns, but when the market crashes, high leverage trading tends to amplify risks, causing investors to face the risk of liquidation. Historically, many financial collapses have been closely related to excessive leverage.

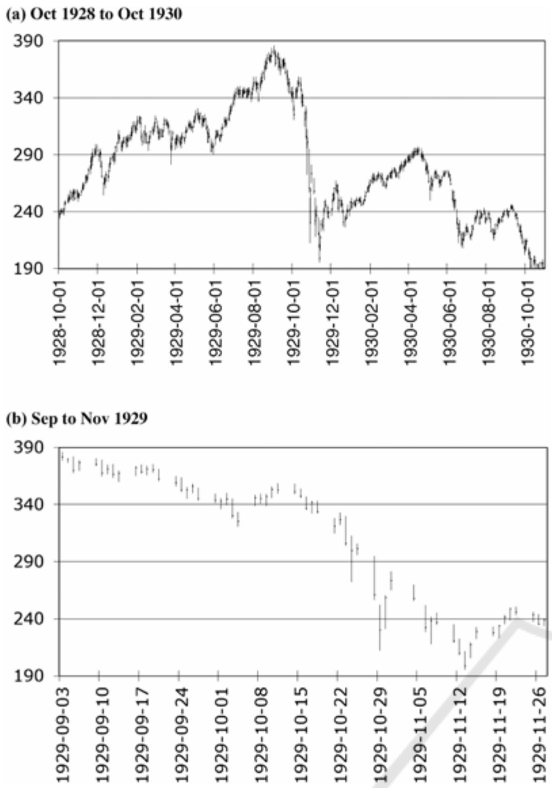

Figure 1: Leveraged Trading and Market Collapse in the Wall Street Crash of 1929 (Borowiecki et al., 2023).

The 1929 Wall Street stock market crash is a classic example of leveraged trading. As shown in Figure 1, in the 1920s, stock market speculation was prevalent, and investors widely used margin loans for leveraged trading (Cao, 2010). At that time, investors only needed to pay 10% of the stock price as margin to borrow funds to buy stocks. This highly leveraged trading magnified the market's rise in the bull market, but when the stock market began to fall, the leverage effect caused losses to be sharply magnified, leading to large-scale liquidation and market collapse (McNamara & Bromiley, 1997). The first reason is the amplification of the leverage effect. Because of excessive leverage, investors are unable to add margin in time when the market goes down, and are forced to close their positions, further exacerbating the decline of the stock market (Borowiecki et al., 2023). The spread of systemic risks also accounts. Highly leveraged market participants occupy a considerable market share, and their liquidation behaviour exacerbates the panic in the market, forming a self-reinforcing downward cycle.

In 2021, Archegos Capital's liquidation due to high-leverage trading further revealed the risk management issues of leveraged trading. Archegos used derivatives such as Total Return Swaps (TRS) to invest with extremely high leverage. However, due to market volatility and the decline in the share prices of its holdings, Archegos failed to meet margin requirements in a timely manner and was eventually forced to liquidate, causing the prices of related assets to plummet and triggering widespread losses for financial institutions. Archegos's liquidation incident shows the huge risks of leveraged trading in the financial derivatives market, especially when using derivatives for high-leverage investment, small market fluctuations may lead to liquidation (Cheng & Wang, 2022). In the Archegos incident, the lack of effective risk management and transparency, especially the lack of supervision on leverage risks, prevented financial institutions from effectively identifying their potential risks, resulting in systemic shocks in the market (Goldberg & Mahmoud, 2017).

3.3 Limitations and Improvements of Traditional VaR Models

Value at Risk (VaR) is a common tool used by financial institutions to measure portfolio risk. It provides the maximum loss that a portfolio may suffer at a given confidence level. However, the performance of the VaR model in extreme market environments has significant limitations. The basic idea of the VaR model is to calculate the maximum possible loss within a certain time frame through historical data or simulation methods. Although VaR is widely used in daily risk management, it has limitations in the following aspects:

- Underestimation of tail risk. The VaR model based on the normal distribution assumption cannot capture the risk of extreme events in the fat-tail market (such as flash crashes), resulting in the failure of tail loss prediction (Goldstein & Taleb, 2007).
- Lack of liquidity risk. The VaR model that relies on historical volatility parameters cannot reflect the real risk of abnormal price fluctuations when market liquidity dries up (McNeil et al., 2015).
- Short-sightedness in time dimension: The short-term data dependence characteristic conceals the long-term risk lag effect in the market bubble accumulation and high leverage environment (Goldberg & Mahmoud, 2017).

In order to overcome the limitations of the VaR model, scholars have proposed a variety of improvement plans, especially introducing the perspective of behavioural finance to better capture irrational factors in the market. By introducing sentiment indexes in behavioural finance (such as the market panic index), using big data to dynamically adjust the VaR model, and combining conditional value at risk (CVaR) to capture tail risks, the ability to predict and manage risk events such as extreme market volatility and liquidity crises can be improved.

Therefore, the failure of EMH, the risk of liquidation caused by leveraged trading, and the limitations of the traditional VaR model all reveal the fragility of the financial market in the face of extreme events. Improvement measures combined with the perspective of behavioural finance are expected to provide more effective risk management tools to help the market better cope with the impact of extreme events such as crashes and flash crashes. Future risk management should focus on dynamic adjustment and the introduction of irrational behavioural factors to improve the stability and risk resistance of the market.

4 POSITION LIMIT AND RISK CONTROL STRATEGY

The position limit system is an essential tool in the financial market. It aims to control the position of a single investor or institution in the market, prevent market manipulation, excessive speculation and leverage risks, and ensure the healthy and stable operation of the market. Its core goal is to reduce the systemic risk of the market, prevent market prices from being manipulated by individual large investors, and maintain the fairness and liquidity of the market. The theory of the position limit system is based on the market microstructure theory, which focuses on how market participants trade under incomplete and asymmetric information. The position limit system helps improve the transparency and fairness of the market and ensures that prices can fully reflect the relationship between supply and demand without being affected by a few large investors. By limiting positions, the market can more healthily reflect the collective judgment of investors rather than being dominated by a single market participant (Zhou, 2020).

The position limit system in the US futures market is regulated by the Commodity Futures Trading Commission (CFTC). According to CFTC regulations, the position limit of certain futures contracts is strictly limited, especially for speculative traders. The position limit policy in the US futures market has achieved certain success, especially in reducing excessive speculation and reducing systemic risks. However, with the development of financial innovation and derivatives markets, traditional position limit policies face new challenges, such as the impact of high-frequency trading and algorithmic trading on the market, and how to balance liquidity and market stability.

4.1 The Impact of Position Limits on Market Stability

The position limit system has a dual impact on market stability. On the one hand, position limits can effectively prevent market manipulation and excessive speculation, and reduce systemic risks; on the other hand, overly strict position limits may have an adverse impact on market liquidity and inhibit market activity. Position limits’ inhibitory effect on market manipulation and systemic risk. The core role of the position limit system is to reduce market manipulation and reduce systemic risks. In the absence of position limits, the speculative behaviour of a single large investor or institution may cause drastic market fluctuations or even market collapse. For example, in the Wall Street crash of 1929 and the financial crisis of 2008, excessive leverage and uncontrolled speculation exacerbated the systemic risk of the market. The position limit system can effectively mitigate these risks by controlling the positions of individual market participants. In the absence of position limits, investors may manipulate prices through centralized transactions, causing market imbalances. The position limit system reduces the market influence of a single investor, allowing market prices to more fairly reflect the relationship between supply and demand (Zhou, 2020). Highly leveraged traders may face the situation of being unable to add margin due to market emergencies, which may lead to forced liquidation, further exacerbating the downward pressure on the market. By implementing position limits, investors' risk exposure is effectively controlled, thereby reducing the transmission of market systemic risks.

Potential impact of risk positions on market liquidity and trading activity are as follows:

- Although the position limit system can curb excessive speculation and risk concentration, it may also have a potential negative impact on market liquidity. Too strict position limits may cause market participants to reduce trading volume, which in turn affects the depth and price discovery function of the market.
- Limited liquidity. If the position limit is too strict, some investors in the market may be forced to exit the market, resulting in a decrease in market liquidity. For example, during the

2008 financial crisis, some investors had np ability to adjust their positions due to the position limit policy of regulators, which to some extent exacerbated the liquidity crisis in the market (Tian et al., 2025).

- Suppressing market activity. The position limit system may prevent some investors with large amounts of funds from actively participating in the market, reducing the trading activity of the market. The decline in market activity may lead to increased price volatility, especially when market uncertainty is high, insufficient trading volume may amplify price volatility (Geboers et al., 2023).

4.2 Design of New Position Limit System

With the rapid development of the financial market, the traditional position limit system faces challenges in the face of new trading methods such as high-frequency trading and algorithmic trading. Therefore, how to design a more flexible and dynamic position limit system has become an important issue in modern market supervision. By integrating artificial intelligence and big data technologies, regulators can analyse market dynamics, investor behaviour and sentiment fluctuations (e.g., social media and news sentiment indexes) in real time, and dynamically optimize position limit strategies to improve market stability and liquidity. Real-time risk monitoring and position adjustments can respond to sudden fluctuations (Sun & Li, 2022), while sentiment analysis provides data support for predicting risks (Geboers et al., 2023).

Dynamically adjusting position limit strategies based on market volatility is a future trend. By calculating market volatility indicators (such as risk value), position limits can be tightened when the market fluctuates violently to prevent the spread of systemic risks, and the ratio can be appropriately relaxed during stable periods to maintain healthy market operations (Tian et al., 2025). At the same time, combining algorithms to optimize position limit strategies in real time (e.g., analysing investor behaviour patterns) can break through the limitations of traditional fixed standards and enhance risk response flexibility (Sun & Li, 2022).

Therefore, the position limit system plays an important role in maintaining market stability and reducing systemic risks, but overly strict position limits may have a negative impact on market liquidity. The design of future position limit systems should be combined with emerging technologies such as artificial intelligence and big data to make dynamic adjustments to meet the risk management needs in different market environments. By monitoring market sentiment and behaviour in real time and combining volatility-driven position limit strategies, the relationship between market stability and liquidity can be more effectively balanced.

5 CONCLUSIONS

From the perspective of behavioural finance, this paper reviews the relevant theories and practices of futures market risk management, focusing on the core issues such as flash crashes, EMH failure and leverage blow-up risks, and position limit systems. By analysing existing research results and actual market cases, this paper argues that although traditional financial theories and risk management tools (e.g., VaR models) can cope with conventional market fluctuations to a certain extent, their performance in extreme market conditions has significant limitations. Behavioural finance provides a new perspective for risk management, especially under the influence of investor irrational behaviour, emotional fluctuations and market microstructure, market price fluctuations often show irrational and nonlinear characteristics.

The core theories of behavioural finance, especially investor psychological biases (overconfidence, loss aversion, herd effect, etc.), provide a more comprehensive perspective for futures market risk management. Traditional financial theory assumes that the market is rational, but in reality, investors' irrational behaviour often leads to deviations in market prices. In the futures market, especially in the high-leverage and derivatives market, investors' emotional fluctuations and irrational decisions often become the source of sharp price fluctuations. Flash crashes and market manipulation cases further confirm the profound impact of such irrational behaviour on the market. By combining behavioural finance, researchers have proposed more complex risk management frameworks that can take into account irrational factors in the market, such as market sentiment and group behaviour.

Contemporarily, with the popularity of high-frequency trading and algorithmic trading, the dynamic changes in the market have become increasingly complex, and traditional risk management tools based on historical data and rational assumptions have become insufficient. The theory of behavioural finance provides strong support for explaining these new phenomena, especially the in-depth study of investors' reaction patterns, decision-making processes, and market feedback when facing extreme market fluctuations, making risk management in the futures market more refined and diversified.

Traditional risk management frameworks, rooted in the efficient market hypothesis (EMH) and rational actor assumptions, struggle to address real-world market irrationality and extreme events (e.g., flash crashes, high-leverage risks). Behavioural finance has revolutionized this paradigm by integrating quantified investor sentiment, psychological biases, and behavioural patterns (e.g., social media sentiment analysis) with AI and big data. This fusion enhances risk prediction accuracy, particularly during crises, while mitigating irrational volatility's destabilizing effects on derivatives markets. Dynamic risk management strategies, enabled by real-time monitoring of market sentiment and volatility, allow flexible adjustments to leverage ratios and position limits, overcoming the rigidity of static models. Policymakers can leverage these insights to refine regulations, prioritizing behavioural drivers of systemic risks. Financial institutions must embed behavioural factors into risk models, and investors should adopt adaptive strategies with heightened emotional discipline. Collectively, this approach fosters a resilient ecosystem capable of navigating complex market dynamics, balancing stability with responsiveness to emerging threats.

The traditional risk management paradigm is based on the efficient market hypothesis and the rational person assumption, but in reality, irrational market fluctuations and frequent extreme events (e.g., flash crashes and high leverage risks) have exposed its limitations. The introduction of behavioural finance has revolutionized the risk management framework. By quantifying investor emotions, psychology and behavioural patterns (e.g., social media sentiment analysis), combined with artificial intelligence and big data technology, it has not only improved the accuracy of risk prediction (especially in extreme events), but also enhanced market stability and alleviated the impact of irrational fluctuations on the derivatives market. Dynamic risk management strategies can achieve flexible adjustments to leverage ratios and position limit standards by monitoring market sentiment and volatility in real time, breaking through the rigidity of traditional static models. Policymakers can use this to optimize regulatory policies, financial institutions need to incorporate behavioural factors into risk control models, and investors need to strengthen emotional management and dynamic adaptation of strategies to jointly build a resilient system that adapts to complex market environments.

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