

Limitations of the Black-Scholes Model in China: Short-Selling Constraints and Comparative Analysis with the U.S. and India

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Abstract. The Black-Scholes model revolutionized option pricing under ideal market assumptions (minimal trading friction, no short-selling restrictions...). However, its applicability in emerging markets with critical institutional constraints can be limited. This paper studies how short-selling bans in China violate the Black-Scholes model's assumptions and cause systematic option mispricing in China. Regulatory implications for China's markets, such as Qualified Securities for Short-sale Refinancing program, "T+1" intra-day trading restriction, daily limit on price movements, etc., are studied for their regulatory effects on pricing and arbitrage. The study makes a comparative institutional study on China's markets with US and India's markets that have more flexible market settings. the results show that the restrictive settings in China caused a reverse IMVD and driven significant mispricing, whereas US and Indian markets benefit from freer short selling and improved pricing accuracy. The study provides insight for policymakers to carefully expand the short-selling business in mainland China's capital market, reduce the costs of securities lending, as well as re-arrange trading rules with efficiency as the main target. This study highlights the influence of market mechanism on the Black-Scholes option pricing theory, as well as inspirations and implications for policymakers seeking more efficient, transparent and deeply liquid derivative markets as well as the capital market.

Keywords: Black-Scholes model, Short-selling constraints, Comparative analysis

1. Introduction

Short selling of stocks was banned completely in China's capital markets until 2010. Even after regulators voluntarily instituted a pilot margin trade and securities lending scheme in part (portfolio limit of stocks have another term called "qualified securities margin trading"), short-selling activity was still heavily restricted relative to more complex, more liquid markets. Buying shares to borrow for short-selling in China also has a high cost (annualization fee, for example, is 8-10%), several institutional frictions, and short-selling activity has remained "very low to none" [1]. In addition, China's intra-day trading rules also hinder arbitrage: a T+1 trading settlement rule (ban of the reselling shares on the same day) and +10% and -10% limits on the trading scope of single shares lead to price stabilization in the near future, but by fundamentally inconsistent with those

assumptions of the BS model—there exists frictionless continuous transactions. In this environment, the traditional assumptions on the option pricing are hence challenged and, in this context, this paper questions whether the BS model applies in China.

Limiting short sales distorts asset prices by suppressing the incorporation of negative information into prices. Similarly, without short sellers prices reflect only “optimistic valuations” and that equities are thus overvalued [2]. Later work confirms that shorting constraints postpone correction from negative valuations, and give equities “bubbles”. Although some argue that suppressing short selling can curb volatility and fluctuations, they report the opposite: retail imposition of a market-wide ban on short selling works against liquidity and harms prices [3].

When it comes to options markets, the inability to short the underlying obviates the arbitrage process in the BS model that the model depends on and leads to model mispricing. Prior studies have indeed observed option pricing deviations in emerging markets. For example, large P-valuedow deviations from the options BS valuation on China’s new options market but did not single out the short-sale frictions as the underlying reason [4]. This study attends to that gap of study by answering how short-sale frictions influence BS-model option pricing efficiency in China’s market. The study exploits a quasi-natural experiment provided by China’s gradual rollout of the short-selling program in its capital market, in particular, the new Qualified Securities for Short-sale Refinancing rollout that gradually increases the stock supply for loanable shares. Leveraging this set up, this study examines the influence of eased short-sale restrictions on Black-Scholes implied volatility and pricing deviations.

Finally, this study examines China’s experience from a comparative point of view with both the United States and India markets. Thus, an unrestricted short-selling economy and a newly liberalized one is compared to understand China’s experience. These findings show that the robust short-sale restrictions in China cause significant and systematic option mispricing and explain when and how the Black-Scholes model will fail in a restricted market. These insights extend option pricing theory to more realistic market conditions and have practical implication: they highlight the trade-off between short-term market stability and efficiency in the pricing of options for the policymakers; they also help investors to adjust the estimates of volatility and hedging positions in the markets of short-selling frictions.

2. Short-selling constraints in China

China’s capital markets are constraining to short selling. After 2010, and over time, regulatory authorities allowed short selling on more stocks within designated programs, but these programs remained tightly constrained. Short sellers were substantially limited by financial constraints: margin requirements were high, stock borrowing fees used to be on average of 8-10% per year. These fees significantly deterred arbitrageurs from taking a short position. An 8-10% annual loan fee is effectively equivalent to a ban [5]. So, short-selling volumes in China were exceedingly small in proportion to overall trade volumes until the launch of the QSMT program.

2.1. Trading rules and additional frictions

Other than the direct shorting constraints, China’s trading rules also impose additional shorting frictions that differ from fair prices. The T+1 settlement rule (there is no intra-day sale of purchased shares) will put pressure on liquidities and hamper arbitrage and contradict the BS model’s assumption of continuous trading. The trader cannot short a stock to hedge an option until next trading day, and by then the opportunity may already have been lost, because market conditions may

entirely change. Consistent with this, it has been found in a number of studies that in China, for instance under T+1, there exist a number of delta-hedged option trades that take abnormal intraday returns, which drop off overnight, at least reflecting some unexploited price discrepancies.

Similarly, the exchanges impose ± 10 percent daily price move limits on stocks on the mainboard and ± 20 percent on the STAR board market. Such price limits prevent large single-day price moves in stocks but also create gradual rather than continuous information incorporation. For example, if bad news leads to a 20 per cent price drop, a 10 per cent price limit sees the adjustment start over several days, contradicting the BS Model's assumption of continuously adjusting prices. However, the need to do that adjustment shows how trading rules like T+1, price limits introduce discontinuities that are unmodeled by the standard Black-Scholes model.

2.2. Option pricing distortions under constraints

China's short-selling restrictions and frictional impediments to trading options result in easily identifiable pricing deviations of stock options. With shorting the underlying difficult or cheap, put options effectively become (one of) the main alternatives for investors expressing bearish sentiment or obtaining downside protection. This extra demand pushes up put option prices (and their implied volatilities) above Black-Scholes model pricings without friction. On the other side, call options can be undershooting (relative to fundamentals) because arbitrageurs, who would usually make use of this mispricing (short the cheap stock and buy calls, or vice versa), are prohibited. Net effect is a breakdown of the typical put-call parity relationship under large restrictions.

For example, in 2015 market crash in China, put options on major indices were traded at very high prices, much higher than the Black-Scholes values, due to on-going uncertainty and bullish outlook. Call options were traded at a discount, which reflect the investors' need to pay premium for bearish expose when short selling was fully prohibited. In sum, free short selling "safety valve" not being available, misvaluations that would be arbitrated away in an open market persist in China. Price risk stresses in China are implications of a steeper expected vol skew (particularly high-priced downside puts) and costly violations of the pricing relationships. This presents a signal that the Black Scholes model does not hold under market frictions of one-sidedness.

3. Short-selling regime comparison

3.1. China: strict, long-standing constraints

China's short-selling regime is one of the most restrictive of any of the world's largest capital markets. Only a restricted class of stocks can be shorted (under the QSSR scheme), and even so, short-selling activity is very restricted. Short positions are a small fraction of trading volume, especially for long leverage (margin finance) activity, which has blossomed. Borrowing rates are about 8-10% per annum, stringent borrowing cash collateral charges are entrenched and short-selling is expensive. In result, there is an asymmetrically one-sided market in which bear bets are scarce. This long-standing restricted environment exists hand in hand with widespread (persistent) pricing inefficiencies. As explained earlier, Chinese equity options exhibit systematic deviations from Black-Scholes values and negative information enter stock prices more slowly. Long-only speculation has influenced how prices develop and biased price discovery; the Chinese market exhibits the common anomaly explained in Section 2 quite frequently. In short, China's severely restricted short-selling environment encourages recurring model violations and reduces price efficiency.

3.2. United States: liberal and market-driven

In contrast, the United States has a highly liberal short-selling environment. Short selling is a routine part of US market activity, supported by broad stock lending and low borrowing fees (often under 1-2%). Regulators tend to be lax; apart from a few crisis attempts at intervention, there have been few protracted short sale bans. These studies found that stocks with relatively high short interest trade most efficiently in terms of price and with better liquidity. One major exception was the two-week short sale ban on financial stocks in September 2008, right at the height of the global financial crisis. The short sale ban on that occasion offered a nice natural experiment: shorting volumes fell almost by 70%; liquidity deteriorated (wide bid-ask spreads), volatility increased; and prices of the banned stocks still fell. Price discovery was clearly impaired with pessimists shut out. Options markets too were strained with put option prices (volatility) as investors sought various ways to short during the ban when they veered upwards. This was later normalized after the ban was lifted.

Overall, the U.S. case illustrates the costs of short-sale restrictions. Even a short-lived ban has induced considerable inefficiencies, and by the same token, the U.S. case illustrates the gains from a market-driven regime that leaves short selling more or less free.

3.3. India: from prohibition to liberalization

Indian experience provides a mixed view, having moved from a previously prohibitive regime to a relatively open one as it sees a period of rapid growth, liquidity deepening, and the need for accurate pricings to efficiently allocate capital. In the early 2000s, India outright banned all shorting activities by investors (after a market scandal in 2001), reflecting trust adversity in bearish speculative activities. Almost all of that decade shorting was virtually absent in the Indian market and its alleged absence was used as one of the factors limiting the liquidity and efficient price discovery in Indian market. Starting in the year 2008, however, Indian regulators drastically flipped from this approach: SEBI in India devised a comprehensive set of frameworks for short selling, allowing both institutional and retail traders to short stocks in India, and notably introducing a formal securities lending and borrowing framework that would provide the requisite stocks loan for liquidity.

Looking so far felt like reaching an inflection point. India largely dispensed with its prior anti-hoodwinking approach to short sales and embraced short sales' role in a healthy market to reflect accurately on pessimistic information. Following the reforms, there was a noticeable improvement in market liquidity and efficiency in market pricing. India largely avoided reimposing blanket bans on short sales in later bouts of extreme market volatility (such as COVID-19 crisis in 2020), instead with tightened margin requirements for mechanisms to ride out these calamities. India's experience shows the efficiency of abandoning a prohibitive position to move to a balanced position: short selling allowed under adequate safeguards strengthened the derivatives market, improved market pricing precision and the feared instability did not emerge.

3.4. Comparative insights

Overall, the harsher and more long-lasting the short-sale restrictions are, the larger the pricing inefficiencies observed [6]. China's restrictive policies are mirrored by frequent option mispricing and slow incorporation of bad news. The U.S. short-sale regime is largely free; hence, great mispricings are rather rare. This was only as observed under the temporary ban of short-sale in 2008, when substantial mispricing occurred and it vanishes once the ban was lifted. The evolution of the Indian case provides a before-and-after example: pre ban (short-sale prohibition) in 2008, the market

is profligate in liquidity and significant inefficiencies occur; after this liberation period, the market quality and price efficiency improve dramatically [7].

This comparison dovetails with classic financial theory: markets with binding constraints on short sales should tend towards overvaluation and slower price adjustment, which is exactly what this paper sees in the Chinese (and previously Indian) market. In contrast, when short selling is permitted under proper regulation as it is in the US and contemporary India, markets are better able to self-correct and maintain no-arbitrage pricing relationships. Finally, it makes the important case that a sensible, flexible regulatory policy, for instance by means of margin rules or position limits, rather than outright bans, can smooth out volatility without destroying the informational value of short selling. In sum, this cross-market analysis emphasises that constraints on short sales are a root cause of the limitations of the Black Scholes equation in certain markets, and that allowing constraints relaxes is a plausible recipe to improve pricing efficiency.

4. Recommendations and implications

First, increase short-selling supply mechanisms. Regulators could expand and improve securities lending mechanisms to encourage supply of shares that can be short sold. Practically, regulators can enlarge short-sell programs (adding more stocks to the list of eligible stocks), and encourage large retail and institutional investors to do more securities lending [8]. Creating a larger pool of shares that can be borrowed to assist short selling can benefit short sellers more easily to take short positions, which helps reflect bad news in shares' prices more rapidly and reduce pricing friction effects seen in China's market.

Secondly, lower shorting costs and barriers. Lowering the financial frictions of short selling is a second step. Very high borrowing fees and onerous margin requirements currently discourage arbitrageurs from correcting out-of-line options mispricings. Excessive margin collateral requirements on the returns from a short position as well as fostering competition in stock lending market can lower the borrowing fees. A slight reduction in the constraints can be enough (for example, in required collateral percentage or loan rates) to make short selling more feasible. More available short positions in turn should incentivize higher arbitrage needed to correct uppriced options mispricings to narrow their mispricing [9].

Third, reform trading rules to reduce frictions. Some trading rules can be reformed to reduce frictions. Take, for example, the T+1 settlement rule and relax it partially: allow same day shorting for hedging or T+0 settlement on some stocks could allow arbitrageurs to "discount" mispricing intraday. Likewise, the daily price limit band could be widened (or made dynamic in market volatile periods) so that prices can have free time to adjust to new information [10]. Such reformations could help make actual trading circumstances more in line with the assumption of some models, such as Black-Scholes model, and thus improve model usability. The reforms can proceed gradually with corresponding proper risk-control vigilance to avoid causing undue excessive market fluctuations.

Fourthly, embrace a rational regulatory stance. Comparison reinforces the necessity for regulators to have a more consistent, transparent approach to short selling. Instead of banning or cracking down ad hoc amid market downturns, regulators need a consistent, transparent approach to short selling that acknowledges the legitimate role of short selling in price discovery. Such an approach can, for instance, introduce clear, defined grounds for any short-sale ban (and placing enforcement efforts specifically on detected market manipulation, not on generally permissible short selling) to reduce uncertainty and foster a better market sentiment.

In essence, short sellers should be treated as a normal part of the market ecosystem. These regulatory tools can be calibrated and subtler, such as circuit breakers, uptick rules or higher

temporary margins during crises, than an outright ban. If an attitude towards short-selling can also be more rules-based and neutral to short-selling, investor sentiment can remain strong at turbulent times and more types of mechanisms inside the market are free to work. Over the longer term, normalization of short-selling as an allowed transaction (under some supervision) will lead to fitter options pricing and a fitter market.

5. Conclusion

These findings confirmed that when short sales were strongly regulated, options were far away from Black-Scholes prices (options, especially puts, traded at inflated prices). Conversely, if short-selling regulation were loosened (for instance, when a stock qualified for securities lending), mispricing shrank and option prices moved toward theory. Cross-comparisons among markets illustrated the same point: China's mispricings were way more dramatic than those in the USA (where short selling is very lightly regulated), and the China option markets behaved more efficiently after it liberalized short selling. These findings conformed to the theoretical model expectation that market imperfections, such as short-selling ban or short sale costs, will compromise the validity of traditional pricing models.

This study is one of the first empirical assessments that isolates the effect of short-sale restrictions on option prices in China, filling a critical gap in the literature. Adding the U.S. and India into the sample is consistent with a general pattern predicted by classic theory: loosening short-sale restrictions makes markets more efficient even in emerging markets. The results are practical to regulators as they understand the trade-offs associated with short-selling policy: easing excessive restrictions can lower the level of option mispricing without jeopardizing the stability of the market. As is true for any paper, this study has weaknesses: study a single market and a time frame, and the international part of the results is largely qualitative. Future research can consider other markets or use high-frequency data to study these effects. Nevertheless, the evidence confirms the presence of short-selling restrictions as a major source of option mispricing in China and the importance of alleviating these frictions if classical models such as the Black-Scholes model are expected to function well in such markets.

References

- [1] Su, J., Lin, X.J., and Li, Z.R. (2022) Short-Selling Restrictions and Market Efficiency: Evidence from China's QSSR Program. *Pacific-Basin Finance Journal*, 72, 101694.
- [2] Miller, E.M. (1977) Risk, Uncertainty and Divergence of Opinion. *J. Finance*, 32(4), 1151-1168.
- [3] Beber, A., and Pagano, M. (2013) Short-Selling Bans Around the World: Evidence from the 2007-09 Crisis. *Journal of Finance*, 68(1), 343-381.
- [4] Zhang, W., and Zhao, Y. (2020) On the Pricing Efficiency of China's Options Market: Evidence from ETF Options. *China Finance Review International*, 10(1), 55-78.
- [5] Boehmer, E.K., and Schultz, P.J. (2011) The Shorting of the Pricing of Options. *Rev Fin Stud.*, 24(12), 3389-413.
- [6] Briscov, A., Goetzmann, W.N., and Zhu, N. (2007) Efficiency and the Bear: Short Sales and Markets Around the World. *Journal of Finance*, 62(3), 1029-1079.
- [7] Chang, Y.F., Chen, J., and Song, J.K. (2021) Pricing Equity Options in the Chinese Market: A Double Stochastic Volatility Jump Diffusion Approach. *Journal of Futures Markets*, 41(9), 1292-1313.
- [8] Diamond, D.W., and Verrecchia, R.E. (1987) Constraints on Short-Selling and Asset Price Adjustment to Private Information. *Journal of Financial Economics*, 18(2), 277-311.
- [9] Hong, H., and Stein, J.C. (2003) Differences of Opinion, Short-Sales Constraints and Market Crashes. *Review of Financial Studies*, 16(2), 487-525.
- [10] Li, X.T., and Wang, H. (2024) Option Arbitrage Under China's T + 1 Settlement System: Evidence from the Intraday Returns. *Pacific-Basin Finance Journal*, 83, 102316.