Put–Call Parity and Arbitrage Opportunities: An Empirical Analysis on Bank Nifty Options

Arjun Balakrishnan

PGDM Finance

Madras School of Economics

Presented to Dr.Rakesh Nigam

October, 2025

Contents

Acknowledgements

I would like to express my sincere gratitude to my professor, Dr. Rakesh Nigam, for his invaluable guidance, constructive feedback, and continuous encouragement throughout the course of this research. His profound knowledge and enthusiasm for the subject have been a major source of inspiration, fostering in me a deep interest and curiosity to explore the underlying theoretical and practical dimensions of this field. I am also grateful to my peers for their thoughtful discussions, collaboration, and support, which have enriched my understanding and contributed meaningfully to this study.

Abstract

This study empirically examines the validity of the Put–Call Parity (PCP) relationship for at-the-money (ATM) option contracts on the Bank Nifty index between January 2025 and September 2025. By collecting daily option and spot prices and applying PCP with and without dividend adjustments, the study identifies deviations that signal potential arbitrage opportunities. The results suggest that dividend adjustments increase the number of apparent arbitrage opportunities due to mismatches between theoretical parity and market pricing behavior.

1 Introduction

Put–Call Parity (PCP) is a fundamental concept in option pricing theory, establishing a relationship between European call and put options with the same strike price and expiration date. A violation of PCP theoretically implies the existence of arbitrage opportunities.

For an underlying asset such as the Bank Nifty index, this relationship can be tested empirically using market option prices. The key objective of this research is to:

- Examine whether PCP holds for ATM strikes for different maturities.
- Incorporate dividend adjustments into the PCP formula.
- Identify and quantify arbitrage opportunities over time.

2 Theoretical Framework

2.1 Put–Call Parity without Dividends

For a non-dividend-paying asset, the PCP relationship is given by:

$$C - P = S - Ke^{-rT} \tag{1}$$

where:

- C = Call option price
- P = Put option price
- S = Spot price of the underlying asset
- K = Strike price
- r = Risk-free interest rate
- T = Time to maturity (in years)

2.2 Put–Call Parity with Dividends

For dividend-paying assets or indices, the parity adjusts to:

$$C - P = Se^{-qT} - Ke^{-rT} \tag{2}$$

where:

- q = continuous dividend yield

2.3 Arbitrage Condition

If:

$$\left|(C - P) - \left(S - Ke^{-rT}\right)\right| > \text{Transaction Cost} \tag{3}$$

then a risk-free arbitrage opportunity without dividends theoretically exists.

$$\left|(C - P) - \left(Se^{-qT} - Ke^{-rT}\right)\right| > \text{Transaction Cost} \tag{4}$$

then a risk-free arbitrage opportunity with dividends theoretically exists.

3 Data Description

Daily data from January 1, 2025 to September 30, 2025 is used, including:

- Spot prices of the Bank Nifty Index.
- Call and Put option prices for ATM strikes (rounded average of monthly spot).
- Expiry dates for each contract month (e.g., February expiry for January spot, etc.).

Table 1: Process of ATM Strike Selection

Month	Average Spot	ATM Strike (Rounded)	Expiry
Jan 2025	49215.09	49200	27 Feb 2025
Feb 2025	49376.65	49400	27 Mar 2025
Mar 2025	49465.93	49500	24 Apr 2025
Apr 2025	53093.42	53100	29 May 2025
May 2025	55050.65	55100	26 Jun 2025
Jun 2025	56261.03	56300	31 Jul 2025
Jul 2025	56799.94	56800	28 Aug 2025
Aug 2025	55204.27	55200	30 Sep 2025
Sep 2025	54704.59	54700	28 Oct 2025

4 Methodology

1. **Data Preparation:** Download Bank Nifty spot data and corresponding option price data. The option price data is taken from the NSE website and each day price of call and put is taken from the contract which is expiring the next month. This is done to take the contract where there is high trading activity involved.

2. **Strike Selection:** For each month, compute average spot price and round to the nearest 100 to fix the strike.

3. **Time to Maturity:** Compute $T = \frac{\text{Expiry Date - Current Date}}{365}$.

4. **PCP Calculation:** Compute both LHS and RHS of PCP formula stated above.

5. **Deviation Calculation:**

$$\text{Deviation without Dividends} = \text{Deviation} = (C - P) - (S - Ke^{-rT})$$

$$\text{Deviation with dividends} = (C - P) - (Se^{-qT} - Ke^{-rT})$$

6. **Arbitrage Flag:** Mark as arbitrage if

$$|\text{Deviation}| > \text{Transaction Cost Threshold}$$

5 Results and Analysis

5.1 Summary Statistics (Without Dividends)

Table 2: PCP Deviation Summary (Without Dividend Adjustment)

Statistic	Value
Observations	184
Mean Deviation	9.69
Standard Deviation	455.68
Minimum	-2490.02
25th Percentile	-68.08
Median (50th)	58.96
75th Percentile	134.25
Maximum	2355.99

A total of **63 out of 184** observations (approximately 34%) indicated potential arbitrage when dividends were ignored, using a transaction cost threshold of 120. The mean deviation was in a single digit, suggesting near efficiency, but with wide variation due to market noise and expiry effects.

5.2 Summary Statistics (With Dividends)

Table 3: PCP Deviation Summary (With Dividend Adjustment)

Statistic	Value
Observations	184
Mean Deviation	84.23
Standard Deviation	454.66
Minimum	-2395.11
25th Percentile	10.14
Median (50th)	124.83
75th Percentile	205.57
Maximum	2465.59

When dividend yield was included in the PCP calculation, **85 of 184** cases (about 46%) showed arbitrage opportunities. This rise reflects that dividend-adjusted parity values tend to shift the theoretical boundary upward, revealing more cases where market quotes violate PCP.

5.3 Comparative Observation

- Incorporating dividends **increased** the apparent number of arbitrage cases from 34% to 46%.
- The mean deviation also rose substantially (from 9.7 to 84.2), suggesting that dividend inclusion reduces the theoretical RHS value, leading to larger deviations.
- However, most deviations are small in magnitude and may not be tradable after accounting for liquidity and slippage.

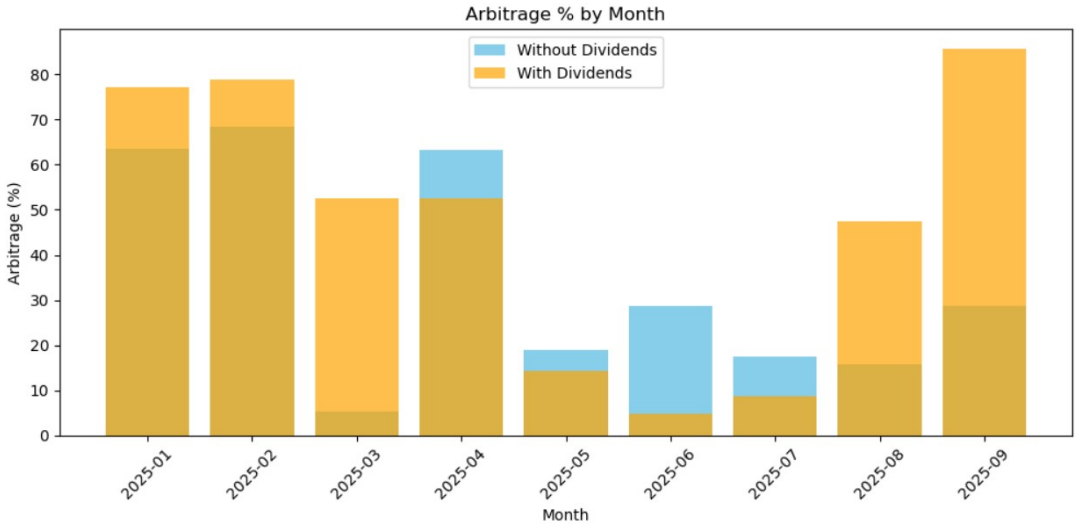

Figure 1: Monthly comparison of the Arbitrage opportunities with and without dividends.

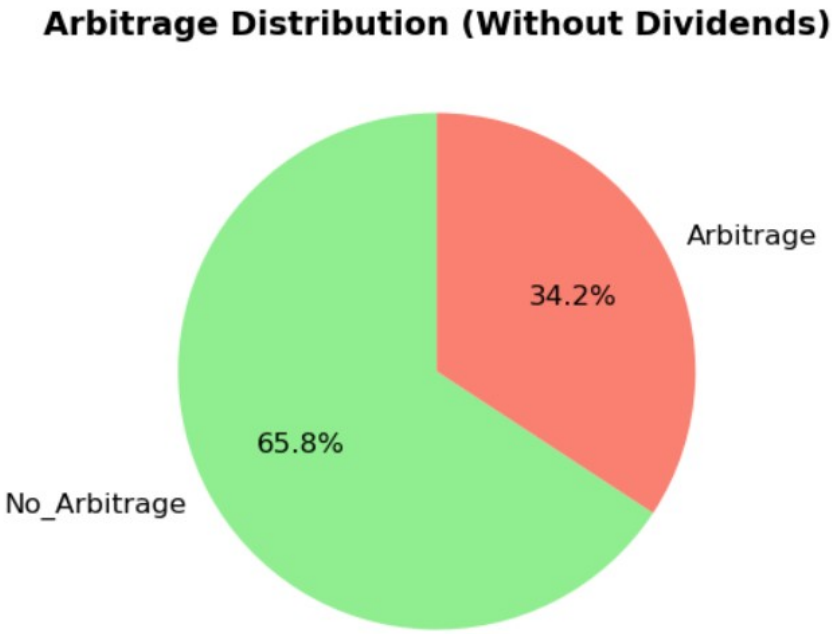

Figure 3: Comparison of Arbitrage Vs No Arbitrage (Without Dividends)

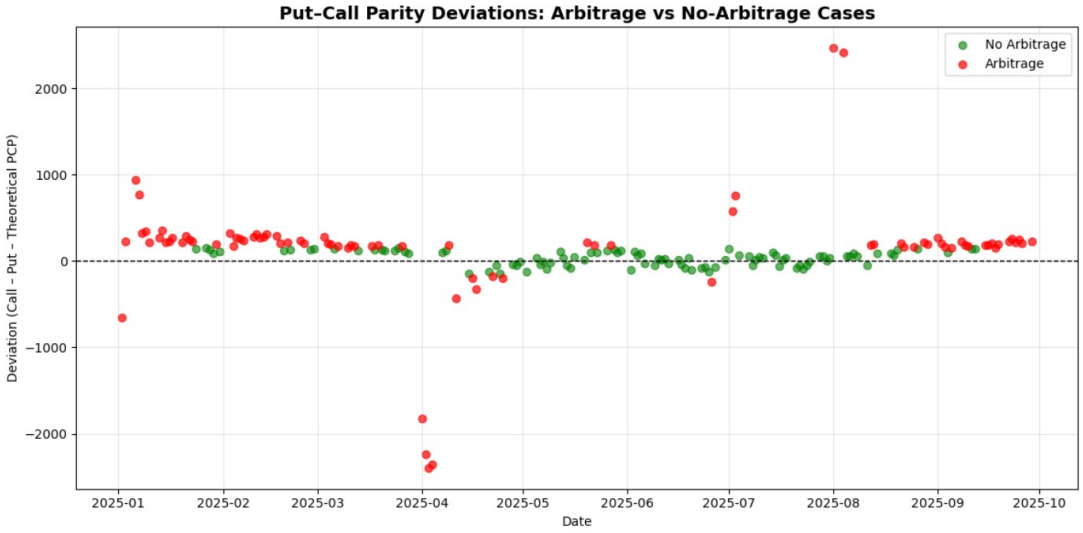

Figure 2: Distribution of PCP Deviations (Without Dividends)

Table 4: Monthly Arbitrage Summary (Without Dividends)

Month	**Arbitrage**	**No Arbitrage**	**Total**	**Arbitrage (%)**
2025-01	14	8	22	63.64
2025-02	13	6	19	68.42
2025-03	1	18	19	5.26
2025-04	12	7	19	63.16
2025-05	4	17	21	19.05
2025-06	6	15	21	28.57
2025-07	4	19	23	17.39
2025-08	3	16	19	15.79
2025-09	6	15	21	28.57
Total	63	121	184	–

We can see that Arbitrage opportunity was more in the months of Janurary, Februrary, April and the lowest in March. The top 3 deviated months are in the first 4 months of the data the year and lowest in the financial year ending month March. The observed spike in Put–Call Parity deviations during January and February 2025 corresponds to key macroeconomic events notably the Union Budget and RBI's rate cut. These announcements increase volatility, widen bid–ask spreads, and delay price adjustments in derivative instruments, leading to temporary arbitrage opportunities.

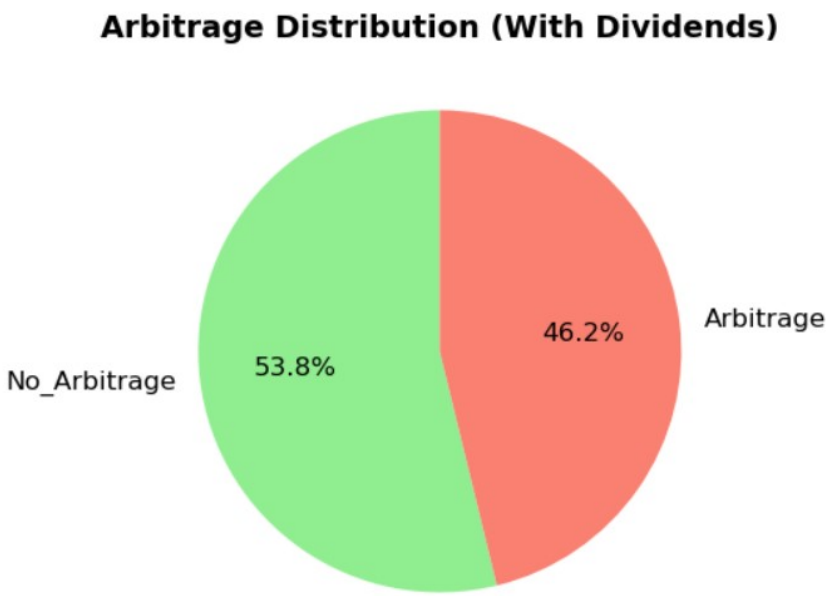

Figure 5: Comparison of Arbitrage Vs No Arbitrage (With Dividends)

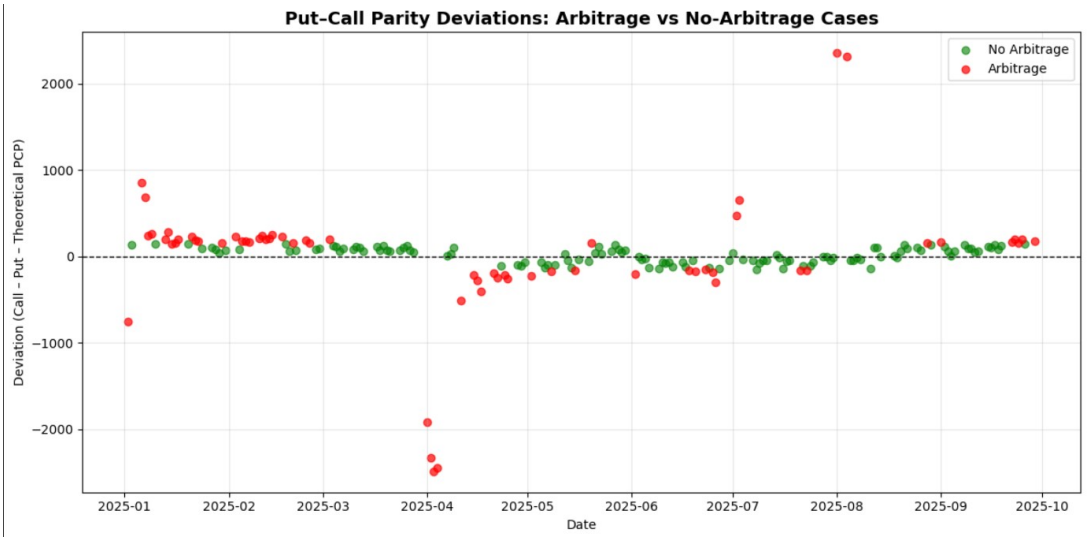

Figure 4: Distribution of PCP Deviations (With Dividends)

Table 5: Monthly Arbitrage Summary (With Dividends)

Month	**Arbitrage**	**No Arbitrage**	**Total**	**Arbitrage (%)**
2025-01	17	5	22	77.27
2025-02	15	4	19	78.95
2025-03	10	9	19	52.63
2025-04	10	9	19	52.63
2025-05	3	18	21	14.29
2025-06	1	20	21	4.76
2025-07	2	21	23	8.70
2025-08	9	10	19	47.37
2025-09	18	3	21	85.71
Total	85	99	184	–

Overall, while the Bank Nifty options market demonstrates near–put–call parity efficiency, dividend-adjusted analysis reveals more frequent—but not necessarily exploitable parity violations. The sharp rise in Put–Call Parity deviations in September 2025 under the dividend-adjusted framework corresponds to the dividend declaration and ex-dividend adjustments of major Bank Nifty constituents. During these months, expected versus realized dividends create temporary valuation mismatches between theoretical and market option prices. Consequently, arbitrage opportunities appear higher when dividends are included, even though the unadjusted parity model shows stable behavior. This demonstrates the importance of accurately incorporating dividend expectations in option pricing, particularly for index options linked to high-dividend-weighted sectors such as banking.

6 Discussion

- Dividend adjustments lower the theoretical RHS, making LHS appear larger.
- Market pricing already incorporates expected dividends through futures discounts.
- Using futures price instead of spot can show better results with dividends in the put-call parity.
- The results might differ for Nifty 50 options or other indexes.
- True arbitrage is rarer than apparent PCP violations — after accounting for transaction costs.

6.1 Limitations

- Use of closing prices may not capture intraday arbitrage windows.
- The dividend yield used is an approximation.
- Futures price can be tested with dividend rather than spot bank nifty prices.
- When trying to trade in real time we might not be able to execute at the said price due to other external factors.

7 Conclusion

The study aimed to empirically test the validity of the Put-Call Parity (PCP) relationship for Bank NIFTY options over the period from January 2025 to September 2025. The analysis was conducted using daily option prices for at-the-money (ATM) and near-the-money contracts, with and without adjusting for dividends. The PCP relationship was evaluated using the formula:

$$C - P = S - Ke^{-rT}$$

where C and P represent the call and put option prices respectively, S denotes the spot price of the underlying index, K is the strike price, r is the risk-free rate, and T is the time to expiry in years. The deviation between the theoretical and actual parity values was computed to identify arbitrage opportunities.

Findings Without Dividend Adjustment

The results indicated that in the absence of dividend adjustments, the mean deviation was approximately 9.69, with a standard deviation of about 455.68. Out of 184 observations, 63 were found to exhibit potential arbitrage opportunities, representing around 34% of the sample. Monthly results showed that arbitrage occurrences were more frequent during January, February, and April, with lower instances during March and August. This suggests that parity violations are not uniformly distributed over time and could be influenced by market liquidity, volatility, or settlement cycles.

Findings With Dividend Adjustment

$$(C - P) = (Se^{-qT} - Ke^{-rT})$$

When dividends were incorporated into the PCP model, the mean deviation increased to 84.23, indicating a higher theoretical adjustment to spot prices. The number of identified arbitrage opportunities rose to 85 out of 184 observations (about 46% of the sample). This demonstrates that dividend-adjusted parity is more sensitive to pricing discrepancies, particularly during months with higher expected corporate payouts or index adjustments.

Interpretation

The increase in arbitrage opportunities after adjusting for dividends suggests that dividend yields have a significant impact on the parity condition, especially for index-based derivatives such as Bank NIFTY. However, it is essential to recognize that not all theoretical arbitrage opportunities are practically exploitable. Transaction costs, bid-ask spreads, margin requirements, and liquidity constraints can eliminate the profitability of such trades in real-world execution.

Furthermore, periods with heightened volatility (for example, around macroeconomic announcements or policy meetings) tend to show greater deviations from parity, reflecting market inefficiencies or delayed price adjustments between the cash and derivatives segments.

Conclusion and Implications

Overall, the empirical evidence indicates that the Put-Call Parity for Bank NIFTY options holds approximately well under normal market conditions, but deviations are observed frequently enough to signal short-term mispricings.

In conclusion, while PCP remains a strong theoretical framework underpinning option valuation, its empirical adherence is partial in emerging markets such as India, primarily due to institutional and transactional frictions. Future studies can extend this analysis by incorporating intraday data, volatility indices, and alternative risk-free benchmarks to further refine the understanding of parity relationships in derivative markets.

References

[1] Hull, J. C. *Options, Futures, and Other Derivatives*. Pearson.

[2] Thomas J. Finucane *Put-Call Parity and Expected Returns*. Cambridge University Press

[3] Black, F., & Scholes, M. (1973). *The Pricing of Options and Corporate Liabilities*. Journal of Political Economy.

[4] National Stock Exchange of India, `https://www.nseindia.com`