EFFICIENCY OF INDIAN STOCK MARKET- A STUDY OF EXISTENCE OF ARBITRAGE GAINS THROUGH PUT CALL PARITY

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ABSTRACT

Put call parity is the no arbitrage condition which must hold true for an efficient financial market. The present study examines the Indian stock market efficiency by using different option contracts for about 400 observations during three consecutive months. Deviation in PCP model provides opportunity to earn abnormal profits to arbitrageur. Three different scenarios have been considered for testing the PCP model. Our result in all scenarios shows the mispricing in the Indian stock market. The empirical analysis provides the level of profit which can be made by arbitrageur. The findings show that Indian stock market as inefficient market.

Keywords: Put Call parity, Market efficiency, Arbitrage profit.

JEL Classification: G14

INTRODUCTIONS

Market efficiency is one of the important factors for the smooth functioning of the financial markets. It ensures that all information regarding price or stock is available in the market. Stock market efficiency implies that the share prices adjust new information rapidly; reflecting the true prices (intrinsic value) and no trader can make abnormal profit with the presence of overvalued and undervalued stocks (Jones and Netter, 2008). Arbitrageurs always look for the inefficiency moment in the market, so that they can make huge amount of profits.

Strong financial market is always desired for all countries otherwise it will provide an opportunity to make profits using mispricing in the market. Large number of studies have been undertaken worldwide to test the efficiency of the various financial markets and resulted into mixed comments. Ibrahim A. Onour (2009) has applied many statistical tests on index of Saudi stock exchange and found that the prices are not following a random walk. Maria Rosa Borges (2008) reported a result of various tests like runs test, correlation test and variance ratio etc. applied on European stock markets (Germany, Spain, UK, France, Greece and Portugal) that the countries stock market are efficient and follow random walk. Cooray and Wickramasighe (2007) have examined the efficiency of South Asian regions (Bangladesh, India, Pakistan and Sri lanka) and reported a strong financial market except for Bangladesh. Azeez, B.A.

and Sulaiman, L.A. (2012) found that stock prices are reflecting all information in Nigerian stock exchange and holds efficient market. Many studies have reported that the various stock markets are not always efficient; there are some time durations when information is not adjusted by prices (Lim, Habibullah and Hinich, 2009), (Alajbeg et al, 2011), (Shiguang Ma and Michelle, 2001), (Subha, 2010). Efficiency has been examined using different methods such as ACF (Vulić, 2009) to find out correlation between current and lagged values of the same series to assess that correlation coefficients are significantly different from zero or not, which is the measure of market efficiency, run test (Sharma & Seth, 2011), (Gimba, 2012) to assess the randomness of the data which ensures that all values are occurring independently, Event study analysis (Brown & warner, 1985) to identify the effect of particular event on stock prices, whether it is possible to forecast the stock returns due to any related announcements which leads to efficiency or inefficiency in the market, Black Scholes model (Bhattacharaya, 1980) used to find out the price of put and call options in an efficient market assuming no transaction cost and dividend and Put call parity (Vipul, 2008) to find the arbitrage possibilities. Among these models, Put call parity is one of the prominent model for investigating the cross- market efficiency (derivative contracts and underlying stock) because it does not involve any statistical calculations and depends on any 'definite distributional assumptions' to test the stock market efficiency (Islam, Watanapalachaikul & Clark, 2005). PCP is based on simple equation which incorporates and is determined theoretically by diverse micro and macro variables affect the constituents of PCP equation such as stock price, interest rate and option premium.

PCP is the relationship between the European put and call option prices for the same share with same expiration date and same strike price (Stoll, 1969). According to PCP, buying a call and investing money at risk-free rate must be equal to buying a put and purchasing a share, keeping the expiration price and date same for the same share.

$C + Ke^{-r}T = P + S_o$

Where:

C= call option price

K= strike price (Expiration price)

r= risk free rate of return

T = time to maturity

P = put option price

S_o = current share price

$Ke^{-r}T$ = present value of the strike price

PCP is a no arbitrage relationship which states, no one can gain from the buying and selling in stock markets according this equation because value at expiration date (T) in different portfolios made out of PCP equation will be same.

VALUE AT EXPIRATION DATE

	$S_o > K$	$S_o < K$
Call + Cash	$(S_o - K) + K = S_o$	$0 + K = K$
Put + Stock	$0 + S_o = S_o$	$(K - S_o) + S_o = K$

The relationship has been tested for various stock markets for example US stock market (Ackert and Tian, 2001), Italian market (Brunetti and Torricelli, 2005), London option market (Nisbet, 1991), German market (Mittnik and Rieken, 2000), Chicago board option exchange (Bhattacharya, 1983), French index (Capelle-Blanchard and Chaudhary, 2001) etc. and extended in many different directions covering the inclusion of dividend (Klemkosky and Resnick, 1980) and transaction cost (Merton, 1973).

India is an emerging economy which is attracting many investors in expectation of high returns. The present study attempts to investigate the arbitrage possibilities and test the put call parity relationship in Indian stock market between option prices and underlying stock.

DATA

The present study attempts to test the put call parity in the Indian stock market. For this, data have been taken from NSE for 140 companies. (NSE covers 98% of total stock derivative transactions). This test is applied on stock options covering the time span from September 2019 to November 2019. There is no bid and ask in the stock options, the prices reflecting in the computer system are the best buy and best sell prices and there are no chances that the prices displayed are not available to a trader as there is no marker maker. Following are the problems which need to be handled while taking the data.

1) Co-existence of data- For testing the PCP equation, the option prices and stock prices has to be observed at a same time. The availability of high frequency prices will enable the testing more authentic. For testing the equation, the option prices and share prices were taken at exactly the same time. Capelle-Blanchard and Chaudhary (2001) have captured the data within one minute of the time frame.

2) Same expiry with same strikes- The PCP model holds only in the case of same maturity and same strike prices for call and put options. All observations used in testing are satisfying this condition.

3) Adjustment for dividend- If company pays dividend during the life of the option then PCP equation has to be adjusted. It is an expected dividend whose present value (value at the time of entering the contract) needs to be deducted from the share prices. First time Klemkosky and Resnick (1980) have extended the PCP model with dividend.

4) Risk-free rate – 91 day treasury bill rate for the months, September, October and November 2019 were taken from RBI which is to be used as discounting rate.

5) Transaction cost- It is the broker's commission paid at the time of buying and selling of share and option contract. Most of the literatures have taken transaction cost into consideration (Vipul, 2008), (Brunetti and Torricelli, 2005), (Kamara and Miller, 1995). There are many components like commissions, clearing fees and short selling costs which affect the transaction cost (Brunetti and Torricelli, 2005) and it is very difficult to find the exact transaction cost because it varies due to strategy, time, size of the contract and type of the investor. To deal with this

problem we have divided investors into two parts: Small investor (who trade with fewer amounts) and Big investor (who trade with large amount). Prevailing transaction charges were taken from the Indian share trading companies.

METHODOLOGY

In order to find out the arbitrage possibilities, two portfolios are made out of the PCP equation.

Portfolio A $C + Ke^{-r}T - P - S_o \geq 0$

Portfolio B $P + S_o - C - Ke^{-r}T \geq 0$

Riskless profit can be made by buying the under-priced portfolio and selling the over-priced portfolio. An arbitrageur will gain if left hand side of the equations are more than the zero, which shows the mispricing in the market.

To get the better results and arbitrage possibilities, the analysis is divided into three cases. Case X where PCP is tested in cost free market, case Y in which transaction is included for small investor and case Z where transaction cost is taken for big investor.

DATA ANALYSIS

The PCP is tested on Indian stock market to find out arbitrage possibilities and about 140 observations were taken from live market for consecutive three months.

Case X

This case assumes that there is no transaction cost for trading in the market.

Portfolio A $C + Ke^{-r}T - P - (S_o - D) \geq 0$

Portfolio B $P + (S_o - D) - C - Ke^{-r}T \geq 0$

THE BELOW TABLE SHOWS THE NUMBER OF PCP VIOLATIONS IN THE BOTH PORTFOLIOS.

Table 1: PCP Violations without Transaction Cost

Month	Portfolio A	Portfolio B
September	93(68.88%)	42 (31.11%)
October	51 (36.95%)	87 (63.04%)
November	**74 (53.62%)**	**64 (46.37%)**
Total Sample	**218 (53.04%)**	**168 (46.95%)**

The number of violations reported in the table for both portfolios are only for profit chances. Result shows that chances of profit from arbitrage possibilities using put call parity is more in portfolio A. Out of the all observations in total sample Portfolio A is profitable in 53% cases. The PCP violation is mostly in all observations but we cannot conclude that the Indian stock market is not efficient as we have not included the transaction cost in this case.

Using mispricing in the market, one can make large amount of profit. Table 2,3 & 4 shows the amount of profit made in both portfolios for the September, October and November.

Table 2: Descriptive Statistics of profits- September

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	1.97	41.92	0.0047	93	100	3.96	36.38	0.02	40	95.23
(50-100)	0	0	0	0	0	0	0	0	0	0
(100-150)	0	0	0	0		123.38	123.38	123.38	1	2.38
(150-200)	0	0	0	0	0	0	0	0	0	0
(200-250)	0	0	0	0	0	201.65	201.65	201.65	1	2.38
All	1.97	41.92	0.0047	93	100	11.51	201.65	0.02	42	100

Table 3: Descriptive Statistics of profits- October

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	1.14	22.04	0.05	49	96.07	3.95	36.93	0.01	84	96.56
(50-100)	0	0	0	0	0	62.89	68.55	57.23	2	2.29
(100-150)	0	0	0	0		122.38	122.38	122.38	1	1.15
(150-200)	0	0	0	0	0	0	0	0	0	0
(200-250)	0	0	0	0	0	0	0	0	0	0
All	10.17	240.58	0.05	51	100	6.66	122.38	0.01	87	100

Table 4: Descriptive Statistics of profits- November

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	1.74	23.16	0.01	74	100	3.79	47.06	0.01	62	96.78

(50-100)	0	0	0	0	0	0	0	0	0	0
(100-150)	0	0	0	0		0	0	0	0	0
(150-200)	0	0	0	0	0	0	0	0	0	0
(200-250)	0	0	0	0	0	0	0	0	0	0
More Than 300	0	0	0	0	0	554.65	779.21	330.09	2	3.22
All	1.74	23.16	0.01	74	100	21.00	779.21	0.01	64	100

The PCP violations resulted into profits for the arbitrageur, which is presented above in tables. Portfolio A has given average profit of ₹1.97, ₹1017 and ₹1.74 in the month of September, October and November respectively, whereas portfolio B shows the average profit ₹11.51, ₹6.66 and ₹21. So, portfolio B is more profitable than portfolio A. There are very few cases where profit is more than ₹150 and exceptional returns.

Case Y

This case includes the transaction cost for trading in the market. Transaction cost for small investor is taken in this case.

Portfolio A $(C- TC^C) + Ke^{-r}T – (P- TC^P)– (S_o-D-TC^S) \geq 0$

Portfolio B $(P- TC^P)+ (S_o-D- TC^S) – (C- TC^C)- Ke^{-r}T \geq 0$

TC^C = transaction cost on call option
TC^P = transaction cost on put option
TC^S = transaction cost on shares
Chances of making profit through mispricing decrease in the presence of transaction cost.

Table 5: Shows the number of profit possibilities in both portfolios.

Month	Portfolio A	Portfolio B
September	115 (54.76%)	95 (45.24%)
October	82 (40.19%)	122 (59.81%)
November	103 (48.13%)	111 (51.87%)
Total Sample	300 (47.77%)	328 (52.23%)

The number of PCP violations with the presence of transaction cost is reported in above table. The possibilities of profit chances due to arbitrage opportunities are more in portfolio B.

Overall result shows that there are 52.23% profit possibilities in portfolio B. Transaction cost decreases the arbitrage possibilities from 53% to 47.7% for portfolio A and increases from 46.9% to 52.23% for portfolio B.

The level of profit made in both portfolios in this case is shown in the table 6, 7 & 8. The results of this case are not similar to previous case. With the presence of transaction cost, portfolio B turns more profitable. The average amount of profits is ₹7.34, ₹6.22 and ₹14.10 in three consecutive months for portfolio B. In the month of November, portfolio B has reported a maximum profit ₹807.30.

Table 6: Descriptive Statistics of profits- September

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	2.57	17.72	0.02	114	99.13	3.25	48.31	0.01	93	97.90
(50-100)	66.10	66.10	66.10	1	0.87	0	0	0	0	0
(100-150)	0	0	0	0		0	0	0	0	0
(150-200)	0	0	0	0	0	185.88	185.88	185.88	1	1.05
(200-250)	0	0	0	0	0	209.64	209.64	209.64	1	1.05
All	3.12	66.100	0.02	115	100	7.34	209.64	0.01	95	100

Table 7: Descriptive Statistics of profits- October

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	2.02	25.19	0.05	80	97.54	3.99	40.00	0.05	119	97.54
(50-100)	0	0	0	0	0	78.30	81.11	75.49	2	1.64
(100-150)	0	0	0	0		127.55	127.55	127.55	1	0.82
(150-200)	0	0	0	0	0	0	0	0	0	0
(200-250)	247.03	247.03	247.03	1	1.23	0	0	0	0	0
More Than 250	284.39	284.39	284.39	1	1.23	0	0	0	0	0
All	8.45	284.39	0.05	82	100	6.22	127.55	0.05	122	100

Table 8: Descriptive Statistics of profits- November

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	2.47	26.72	0.03	103	100	3.34	49.41	0.01	109	98.20
(50-100)	0	0	0	0	0	0	0	0	0	0
(100-150)	0	0	0	0		0	0	0	0	0
(150-200)	0	0	0	0	0	0	0	0	0	0
(200-250)	0	0	0	0	0	0	0	0	0	0
More Than 300	0	0	0	0	0	601.04	807.30	394.79	2	1.80
All	2.47	26.72	0.03	103	100	14.10	807.30	0.01	111	100

*The above tables reflect the level of violations in the PCP equation.

Case Z

This case includes the transaction cost for big investors. Commission payable on transactions varies with the investor type. Here transaction charges are very low for the big investor who deals with the large amount. Portfolios will remain same for this case as previous case. This case can be considered as more realistic case because this will give some actual mispricing chances. Similar to previous cases, the number of PCP violations reported in the table 9 below.

Table 9: PCP Violations with Transaction Cost (Big Investor)

Month	**Portfolio A**	**Portfolio B**
September	107 (62.57%)	64 (37.43%)
October	71 (39.44%)	109 (60.55%)
November	95 (50.26%)	94 (49.74%)
Total Sample	273 (50.55%)	267 (49.45%)

The number of violations is slightly same in both portfolios which are near to 50% in overall sample. Whereas in the month of September, portfolio A has reported 62.5% violations leading to profit chances. The profit made out of two portfolios is reported in the table 10, 11&12.

Table 10: Descriptive Statistics of profits- September

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	2.01	16.36	0.01	106	99.06	3.98	45.59	0.02	62	96.87
(50-100)	54.02	54.02	54.02	1	0.94	0	0	0	0	0
(100-150)	0	0	0	0		0	0	0	0	0
(150-200)	0	0	0	0	0	154.64	154.64	154.64	1	1.59
(200-250)	0	0	0	0	0	205.65	205.65	205.65	1	1.59
All	2.49	54.02	0.01	107	100	9.48	205.65	0.02	64	100

Table 11: Descriptive Statistics of profits- October

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	1.62	23.63	0.02	69	97.14	3.77	38.48	0.02	106	97.25
(50-100)	0	0	0	0	0	70.61	72.03	69.18	2	1.83
(100-150)	0	0	0	0		124.98	124.98	124.98	1	0.92
(150-200)	0	0	0	0	0	0	0	0	0	0
(200-250)	248.62	253.43	243.82	2	2.86	0	0	0	0	0
All	8.54	253.43	0.02	71	100	6.10	124.98	0.02	109	100

Table 12: Descriptive Statistics of profits- November

	Portfolio A					Portfolio B				
	Mean	**Max**	**Min.**	**Obs**	**%**	**Mean**	**Max**	**Min.**	**Obs**	**%**
(0-50)	1.96	24.95	0.01	95	100	3.21	48.25	0.01	92	97.87

(50-100)	0	0	0	0	0	0	0	0	0	0
(100-150)	0	0	0	0		0	0	0	0	0
(150-200)	0	0	0	0	0	0	0	0	0	0
(200-250)	0	0	0	0	0	0	0	0	0	0
More Than 300	0	0	0	0	0	601.04	807.30	394.79	2	1.80
All	2.47	26.72	0.03	103	100	14.10	807.30	0.01	111	100

The amount of profit is more in portfolio B. The average amount of profit made is ₹9.48, ₹6.10 and ₹15.43 in September, October and November respectively for portfolio B.

CONCLUSIONS

A VaR model commonly expect a log-ordinary value dispersion process, and that the log return process follows an ordinary dissemination. In any case, genuine money related markets display a few.

This study have analysed the Indian market efficiency by using the Put Call parity model during the period from September 2019 to November 2019. The whole data set has divided into three different scenarios. First scenario has analysed the data without transaction cost, second scenario includes the transaction cost for small investors and third scenario includes the transaction cost for big investor. The findings of this study shows that the chances of profit from PCP violations are 53.05% in portfolio A (Long strategy) for the whole sample and for the portfolio B (Short strategy) is 46.95% in first scenario (Case X) where transaction cost is not taken into consideration. Average profit made is ₹1.97 in portfolio A whereas it is ₹11.51 in portfolio B in September. Above all this, November data shows the maximum profit of ₹779.21 in portfolio B where average profit is ₹21.00. In second scenario (Case Y) where transaction cost is taken for the small investors given the average profit of ₹4.35 for portfolio A whereas in portfolio B it is ₹9.21 for all three months taken altogether. PCP violations are 52.23% in portfolio B which leads to profit chances. Case Z of this study in which we have taken transaction cost for the big investors has also shown the higher average profit in portfolio B (Short strategy) which is ₹10.28 and for the portfolio A it is ₹ 3.87 for all three months taken altogether. The level of profit in this case is higher than the Case Y because of less transaction cost. Transaction cost for big investor is exactly half of the small investor. The efficient market does not provide the chances for arbitrage possibility. From the overall results of all three consecutive months we can conclude that Indian stock market is not an efficient market. It means share prices and option prices are not adjusting the new information rapidly.

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