RELATIONSHIP BETWEEN YIELD FROM BASIS ARBITRAGE & IMPLIED VOLATILITY

Major Research Project

Report

SUBMITTED TO

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CERTIFICATE

This is to certify that **Mr. Ayush Chaturvedi**, student of **Delhi School of Management, Delhi Technological University**, has successfully accomplished the research project work in the partial fulfilment of the requirement of Master of Business Administration (MBA) program for the academic year 2018-20.

The project work is titled as **"Relationship between Yield from Basis Arbitrage & Implied Volatility"**

Dr. Sonal Thukral

(Mentor)

Declaration

I hereby declare that the Research project report titled "**Relationship between Yield from Basis Arbitrage & Implied Volatility**" submitted to Delhi School of Management, Delhi Technological University, in partial fulfilment of the necessities for the grant of the degree of Master of Business Administration, is a record of original dissertation work done by me, under the mentorship and supervision of Dr. Sonal Thukral.

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Place: New Delhi

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Executive Summary

An Arbitrage is a simultaneous purchase & sale of a security, in different markets or in different market segments (For Eg. Spot market & Derivatives market), to benefit from the asset mispricing & a earn a risk-free profit. Arbitrage is considered to be risk-free, since no market fluctuations are speculated by the investor. opportunities Instead, they participate in arbitrage to manipulate security mispricing that has emerged between two connected markets. Therefore, owing to market inefficiencies, arbitrage mechanisms exist. Classical market theories say that the market, having both rational buyers and arbitrageurs, would take care of mispricing and would get stock prices down to their true basic price. But such mispricings still occur in the real world from time to time.

Basis Arbitrage is an Arbitrage strategy where in an Arbitrageur benefits from the mispricing of securities. There is always a difference between the price of a security in Cash Segment & it's derivative in Futures Segment. This difference between the prices is due to the Cost of Carry/Cost of Capital. Cost of carry or cost of capital corresponds to the expenses caused as a result of an investment position being taken. Such costs can include financial costs, such as the interest on bank loans used to acquire a security. They may also involve economic costs, such as the opportunity costs involved in taking up the initial position, or any other costs such as those linked to commodity storage.

Attractive Arbitrage opportunities may exist for a few seconds, & also require continuous monitoring of various securities across segments, across markets. Therefore, for practically benefitting from the Arbitrage strategies, a trader should employ technology & try to automate the procedure as much as possible.

It has been widely believed by the market participants that an Increase in Volatility leads to higher yields by employing Arbitrage strategies. During the process of Research, the author was unable to locate any substantial document confirming this perception. The investment community deals with huge sums of money & should not have any misconception or follow any unproven theory as this may lead to severe repercussions. Through this study, we intend to solve this problem by verifying that whether this belief is true or not.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Background-

An Arbitrage is a simultaneous purchase & sale of a security, in different markets or in different market segments (For Eg. Spot market & Derivatives market), to benefit from the asset mispricing & a earn a risk-free profit. Arbitrage is considered to be risk-free, since no market fluctuations are speculated by the investor. opportunities Instead, they participate in arbitrage to manipulate security mispricing that has emerged between two connected markets. Therefore, owing to market inefficiencies, arbitrage mechanisms exist. Classical market theories say that the market, having both rational buyers and arbitrageurs, would take care of mispricing and would get stock prices down to their true basic price. But such mispricings still occur in the real world from time to time.

While executing an Arbitrage trade, an Arbitrageur should sincerely calculate the Transaction Costs, that need to be incurred while employing the Arbitrage strategy. For Eg. In Indian markets, sale of an option is subject to STT (Securities Transaction Tax), which is equal to 0.05% of Premium Paid, when option is not exercised. But, earlier (till September 2019), if an option was exercised, the purchaser of the option had to pay 0.125% of the Contract Value as STT. This Tax many times caused huge losses to Option traders. Suppose a trader bought 10,000 lots of NIFTY 10000CE for 0.05 & sold it for 0.1. In this case, the STT payable would be INR 37.5 only. Now, suppose the contract expires at 10003 & the trader instead of selling the contract, exercises it. In such a case, the STT payable would have been INR 94 lakhs (approx.) much higher than the profit on the exercising of the contracts (profit being INR 22.5 lakhs). Thus, the trader would have incurred a net loss of INR 71.5 lakhs. Such taxations & other transaction costs, if not taken care of, can lead to huge losses for a trader. This tax provision was amended in July 2019 budget by FM Nirmala Sitharaman in a welcome move to traders.

STT now in case of Option exercising, is charged on the difference between the Strike Price & the Settlement Price, instead of the Contract Value.

Attractive Arbitrage opportunities may exist for a few seconds, & also require continuous monitoring of various securities across segments, across markets. Therefore, for practically benefitting from the Arbitrage strategies, a trader should employ technology & try to automate the procedure as much as possible.

1.2 Problem Description : Relationship between Rate of Return from Basis Arbitrage & Volatility

Basis Arbitrage is an Arbitrage strategy where in an Arbitrageur benefits from the mispricing of securities. There is always a difference between the price of a security in Cash Segment & it's derivative in Futures Segment. This difference between the prices is due to the Cost of Carry/Cost of Capital. Cost of carry or cost of capital corresponds to the expenses caused as a result of an investment position being taken. Such costs can include financial costs, such as the interest on bank loans used to acquire a security. They may also involve economic costs, such as the opportunity costs involved in taking up the initial position, or any other costs such as those linked to commodity storage.

Volatility is a measure of dispersion of a security's price. It can be measured by calculating St&ard Deviation or Variance between the returns from the security.

Volatility can be of two types :

(1.) **Historical Volatility** – As the name suggests, it represents how much deviation the price of a security has exhibited from it's average over the past.

(2.) **Implied Volatility (IV**)- While, Implied volatility is the market's estimate of the probable degree of change in the price of a security in the near future.

In our research, we will be using Implied Volatility as the measure of Volatility & would analyse the relationship between Rate of Return (%) from Basis Arbitrage & Implied Volatility using Regression.

1.3 Objective of the Study-

It has been widely believed by the market participants that an Increase in Volatility leads to higher yields by employing Arbitrage strategies. During the process of Research, the author was unable to locate any substantial document confirming this perception. The investment community deals with huge sums of money & should not have any misconception or follow any unproven theory as this may lead to severe repercussions. Through this study, we intend to solve this problem by verifying that whether this belief is true or not.

2. LITERATURE REVIEW

Many research papers focusing on stocks & index futures pricing, & their relationship with Volatility have been studied & presented in the form of literature review and these can be collectively presented as follows:

1. The lead- lag relationship between the futures & spot prices

2. Empirical testing of futures pricing models. Forecast of the futures-prices using futures-pricing models further classified into 3 sub-groups.

    2.1 Futures pricing models were developed under the assumption of perfect market, no arbitrage argument, & risk free or constant interest rate

    2.2 Futures pricing models were developed under assumption of perfect market, no arbitrage argument & risk free interest rate with considering the effect of market volatility.

    2.3 Futures pricing models were developed under the assumption of imperfect market & incomplete arbitrage argument

3. The arbitrage opportunities & mispricing of stock index futures market

4. Miscellaneous

2.1 Lead-Lag Relationship

Kapil Gupta & Dr. Balwinder Singh (2008) used tick-by-tick data & analyzed the mechanism of price discovery & efficiency of the Indian underlying & futures (Nifty) markets. They noted that between the Indian underlying & futures markets, a very deep & firm relationship exists for the long run. Nevertheless, for the short term, the researchers detected an eloquent deviation from an equilibrium relationship. It thus suggests that both markets (cash & futures) lead to the discovery of prices.

Chung, Sheng & Chen (2008) argued that market imperfection differs across markets in different countries. The researchers also observed that the relationship in the emerging Taiwanese market should be more significant than that of the developed US market. Furthermore empirical findings show that in the Taiwanese market (emerging market), the dynamic interrelationship is greater than in the US & Japanese markets (Developed markets).

Ramaswamy, Suganthi; Shanmugam, Bala (2004) analyzed the share and the index futures segment of the Malaysian stock market in three separate subgroups from 15 December 1995 to 30 June 2001. The research examined the relationship between Malaysia's two markets under observation. The analysis established the presence between the two markets of contemporary relationship & co-intégration.

Fleming, Whale & Otdiek (1996) studied the price mechanism. The share market provides lesser trading costs than the derivatives segment for the individual stocks. Further authors say that the market that has lower transaction costs will respond faster

than other market to the introduction of new information. Eventually authors suggested that the S & P 500 stock market is led by a lesser trading expense.

Whale and Stoll (1990) examined 5-minute, intraday time series properties of returns of various index contracts. Authors noticed that futures returns from the S&P 500 & MM index led underlying stock returns by nearly 5 minutes. It reveals that new information was first disseminated on the futures market.Authors suggested that there was no unidirectional relationship between stock index & index futures. The futures & stock market returns tend to be, in large part, contemporary. They also showed that the cash index lags behind the index futures, even after the infrequent trading effects have been purged.

2.2. Empirical testing of futures pricing models

2.2.1 Perfect Market Model - Cost of Carry model

Wolfgang Buhler & Alexer Kempf (1995) analyzed the German stock market & noticed that the real futures price was considerably lower than what CCM had predicted.

Uno, Brenner, Jun , Marti G; Menachem; Subrahmanyam, (1990) discovered in their first two years of listing, stock index futures of Japan saw consistent declines from CCM's 'fair value'.

Barford Cornell & Kenneth R. French (1983) derived & evaluated the composite index futures price of the S&P 500 & NYSE believing markets were perfect with constant dividend payout & constant interest rate.

2.2.2 Perfect Market Model with Market Volatility - Hemler & Longstaff Model - General Equilibrium Model

K Wangwoo Park , Stephen P. Ferris, Hun Y. Park (2002) analyzed the S&P 500 futures market & argued that investors sell their underlying & futures positions as market volatility rises, with comparatively greater declines in future prices.

Fung & Draper (1999) studied futures contracts trading on Hong Kong Hang Seng Index & noted that the errors in pricing had a positive relationship with volatility in the market. This finding is in line with Yadav & Pope's (1994).

Gay & Jung (1999) observed the relationship between Korean stock index futures market's volatility & mispricing.

Merrick Jr , John J.(1987) analyzed the futures market for S&P 500 indices and found that volatility on the stock market can be regarded as one of the key factors affecting mispricing of futures.

2.2.3 Imperfect Market Model - Hsu – Wang Model

Areou & Pierides (2008) studied the Athens Derivatives Exchange's future pricing behavior & found that the CCM's broader mispricing was because of the costs involved in trading . In addition it was studied the futures segment market in Athens. They observed that volatility & transaction costs cause a substantial part of mispricing in Cost of Carry Model.

Bailey (1989) analyzed stock 50 & Nikkei 225 contracts & observed that the stochastic behavior of the underlying stock averages & futures prices & volumes are strongly related.

2.3 The arbitrage opportunities & mispricing of stock index futures market

Pradeep K. Yadav & Peter F. Pope (1990) noted fairly easy arbitrage gains for lower transaction costs, as compared to holding till expiry where it offers minimal arbitrage opportunities. tThe average return on mispricing is effectively null, wih mispricing limited to a small period by the actions of the arbitraguers. He proved that by considering the lag in 5 minutes intraday data (that was actually present in real-time trading), the index arbitrage yields lesser profits because of the time-lag present between the futures & cash indices.

2.4 Miscellaneous

The weakness of the spot-futures parity was analyzed in the research paper by Dr. R.Kannan, Dr. Sangeeta Mishra, Dr. Dheeraj Mishra (2006). To test the parity, the numerous factors such as time to maturity, market rise or decline, markets being in Contango or Normal Backwardation, were analyzed.The paper noted that in case of certain stocks parity had failed. Arbitrage gains for the far-month futures contracts were observed to be greater than those for near-month futures contracts.

We see again in Wolfgang Buhler & Alexander Kempf's paper (1995), that the securities of Spot Futures are mispriced. The paper indicates that an arbitrageur primarily trades in closest-month delivery futures. It also indicates that the risks involved with trading opportunities for arbitrage was observed to be very low, such that earnings were almost risk-free.

Since mispricing exists in derivatives markets, research paper by Nivine Richie & Robert Daogler (2008) needs to be studied. The paper investigates how long the mispricing persists & the effect of volatility on mispricing. Mispricing in high-volatility months was observed to be much more common than in low-volatility months. The period of mispricing was observed to be independent from the monthly volatility.

3. RESEARCH METHODOLOGY

Possible Scenarios:

Market Type		Condition	Buy	Sell	Other Actions
Contango	**Now**	$P_f > P_s$	Spot	Future	
	At Expiry			Stocks Held	Exercise Future Contract
Normal Backwardation	**Now**	$P_f < P_s$	Future	Borrowed Securities	
	At Expiry		Spot		1. Exercise Future Contract 2. Return Borrowed Securities to the Lender

Table 3.1: Possible Scenarios for Arbitrage

where,

P_f → Price of security in Futures market

P_s → Price of security in Spot market

Here, we have discussed two scenarios:

1. **Contango-** This is a normal/common market situation where the price of the security in Spot market is less than that in the Future market.
   In such a case, a trader will buy the security in the Spot market & simultaneously sell it in the Futures market. The price differential between the two segments would be his payoff at the time of Future Contract expiry.
   At expiry, the prices of the security in the Spot & Futures market would converge. At this point of time, the trader would sell his holdings in the Spot market & exercise the Future contract held.
   The resultant profit (or the price differential between Spot & Future prices at the time of entry in the trade) would be credited to the trader's account.

   Eg. Suppose, on 01 March 2019, RELIANCE is trading at 1000 in spot market & RELIANCE MAR FUT (expiring on 28 March 2019) is trading at 1005. Following the above mentioned process, the trader bought RELIANCE in Spot Market at 1000, sold RELIANCE MAR FUT at 1005. On 28 March 2019, RELIANCE expired at 1010. By selling the RELIANCE stock in spot market, the trader would have earned Rs.10, while losing Rs.5 by exercising the short Future contract, thus gaining a net profit of Rs.5, which is equal to the price differential at the time of trade entry.

2. **Normal Backwardation-** This is a relatively uncommon situation. Here, the Price of security in Spot market is higher than that in the Futures market. Such a situation generally arises when the environment is highly bearish for the coming future. In such a case, the trader should buy the Futures contract & sell borrowed securities in the Spot market. The price differential between the two segments

would be the riskless profit for trader. At the time of expiry of the Futures contract, the trader should buyback the securities from the Spot market, return them to the securities' lender & exercise the long Futures contract.
Eg. Suppose, on 01 March 2019, RELIANCE is trading at 1005 in spot market & RELIANCE MAR FUT (expiring on 28 March 2019) is trading at 1000. Following the above mentioned process, the trader sold borrowed RELIANCE shares in Spot Market at 1005 & bought RELIANCE MAR FUT at 1000. On 28 March 2019, RELIANCE expired at 1010. By buying back the RELIANCE stock in spot market, the trader would have incurred a loss of Rs.5, while gaining Rs.10 by exercising the long Future contract, thus gaining a net profit of Rs.5, which is equal to the price differential at the time of trade entry.

Using this approach, we can find the Yield from Basis Arbitrage.

Using INDIA VIX as the measure of Implied Volatility in the Indian stock market, we can find out the statistical relationship between the Yield from Basis Arbitrage & Implied Volatility, through Regression.

This can test whether the belief of direct proportionality between Yield from Basis Arbitrage & Market Volatility is true or not.

NOTE- The various Transaction Costs have been ignored in our Research because the objective of the research is to study the Relationship between the Yield from Arbitrage strategy and Volatility, and not to study about Absolute Returns.

Assumptions-

1. 10X leverage has been considered for Future segment.
2. Lot Size is assumed to be equal to 1 for all stocks trading in Future segment.

4. Case Analysis

For the purpose of our analysis, we have taken the Adjusting Closing Prices in the Future & Spot markets, Term to Expiry of four major Indian listed corporations, namely Reliance, HDFC Bank, TCS & ITC. These are one of the most liquid stocks in the Indian stock markets & are best representatives of their respective sectors. Using these stocks as the sectoral representatives, we have covered in our analysis, Petro-chemical sector, Banking sector, IT sector & Consumer Staples/FMCG sector. Combined average trading value of these stocks is close to INR 3700 cr.

Further, we have used the INDIA VIX data for each day of March, 2019 series as a measure/representative value of Implied Volatility.

Following our Research Methodology, we have calculated the Annualised Return possible by engaging into an arbitrage trade.

Lastly, using regression analysis, we tried to establish a relationship between Annual Yield & Implied Volatility.

4.1 Data-

Symbol	Date	Expiry	Term to Expiry	FUT Adj. Closing Price	Spot Adj. Close Price	Annualised Return (%)	INDIA VIX
RELIANCE	01-Mar-19	28-Mar-19	28	1234.95	1226.05	8.596812788	16.275
RELIANCE	05-Mar-19	28-Mar-19	24	1245.3	1237.65	8.540996785	15.6575
RELIANCE	06-Mar-19	28-Mar-19	23	1271.1	1264.8	7.182810733	15.61
RELIANCE	07-Mar-19	28-Mar-19	22	1277	1270.25	8.010918585	15.2925
RELIANCE	08-Mar-19	28-Mar-19	21	1274.95	1267.1	9.783519673	14.94
RELIANCE	11-Mar-19	28-Mar-19	18	1308.7	1304.1	6.500329469	14.895
RELIANCE	12-Mar-19	28-Mar-19	17	1335.7	1331.35	6.375574012	15.0975
RELIANCE	13-Mar-19	28-Mar-19	16	1350.65	1347.3	5.15540201	15.2775
RELIANCE	14-Mar-19	28-Mar-19	15	1345.55	1341.55	6.593930197	15.15
RELIANCE	15-Mar-19	28-Mar-19	14	1328.3	1321.65	11.92006765	15.865
RELIANCE	18-Mar-19	28-Mar-19	11	1356.75	1350.05	14.96361587	16.9
RELIANCE	19-Mar-19	28-Mar-19	10	1381.2	1376.55	11.20541108	16.4925
RELIANCE	20-Mar-19	28-Mar-19	9	1380.15	1375.45	12.59435211	16.0325
RELIANCE	22-Mar-19	28-Mar-19	7	1345.15	1341.75	12.00907115	16.275
RELIANCE	25-Mar-19	28-Mar-19	4	1327.95	1324.45	21.91635586	16.6725
RELIANCE	26-Mar-19	28-Mar-19	3	1369.4	1367.25	17.39031195	16.485
RELIANCE	27-Mar-19	28-Mar-19	2	1351.55	1349.25	28.27732324	17.0475
RELIANCE	28-Mar-19	28-Mar-19	1	1360.65	1360	15.85826819	16.6525

Table 4.1

Symbol	Date	Expiry	Term to Expiry	FUT Adj. Closing Price	Spot Adj. Close Price	Annualised Return (%)	INDIA VIX
HDFCBANK	01-Mar-19	28-Mar-19	28	2097.35	2083.35	7.958710645	16.275
HDFCBANK	05-Mar-19	28-Mar-19	24	2113.65	2107.1	4.296574817	15.6575
HDFCBANK	06-Mar-19	28-Mar-19	23	2106.8	2104.25	1.748104319	15.61
HDFCBANK	07-Mar-19	28-Mar-19	22	2126.9	2126.5	0.283703489	15.2925
HDFCBANK	08-Mar-19	28-Mar-19	21	2137.65	2128.2	7.013341361	14.94
HDFCBANK	11-Mar-19	28-Mar-19	18	2139.6	2128.45	9.652333376	14.895
HDFCBANK	12-Mar-19	28-Mar-19	17	2182.2	2171	10.06481564	15.0975
HDFCBANK	13-Mar-19	28-Mar-19	16	2227.75	2226.55	1.117654864	15.2775
HDFCBANK	14-Mar-19	28-Mar-19	15	2229.9	2224.75	5.119688638	15.15
HDFCBANK	15-Mar-19	28-Mar-19	14	2262.85	2253	10.35796899	15.865
HDFCBANK	18-Mar-19	28-Mar-19	11	2269.75	2261.45	11.06760666	16.9
HDFCBANK	19-Mar-19	28-Mar-19	10	2277	2267.75	13.52962392	16.4925
HDFCBANK	20-Mar-19	28-Mar-19	9	2305.65	2299	10.6616926	16.0325
HDFCBANK	22-Mar-19	28-Mar-19	7	2281.6	2276.15	11.34757963	16.275
HDFCBANK	25-Mar-19	28-Mar-19	4	2279.65	2281.3	6.000263025	16.6725
HDFCBANK	26-Mar-19	28-Mar-19	3	2317.65	2311.35	30.14020208	16.485
HDFCBANK	27-Mar-19	28-Mar-19	2	2300.6	2299.45	8.297061486	17.0475
HDFCBANK	28-Mar-19	28-Mar-19	1	2307.8	2302.8	72.03246	16.6525

Table 4.2

Symbol	Date	Expiry	Term to Expiry	FUT Adj. Closing Price	Spot Adj. Close Price	Annualised Return (%)	INDIA VIX
TCS	01-Mar-19	28-Mar-19	28	2004.35	1995.4	5.313224484	16.275
TCS	05-Mar-19	28-Mar-19	24	1995	1988.1	4.796923569	15.6575
TCS	06-Mar-19	28-Mar-19	23	2011.55	1999.6	8.617102056	15.61
TCS	07-Mar-19	28-Mar-19	22	2023.75	2013.3	7.824929198	15.2925
TCS	08-Mar-19	28-Mar-19	21	2032.65	2022.7	7.769236093	14.94
TCS	11-Mar-19	28-Mar-19	18	2020.5	2014.8	5.213854493	14.895
TCS	12-Mar-19	28-Mar-19	17	2019.6	2012.45	6.932533085	15.0975
TCS	13-Mar-19	28-Mar-19	16	2005.4	2000.5	5.078565133	15.2775
TCS	14-Mar-19	28-Mar-19	15	1997.9	1987.4	11.68165546	15.15
TCS	15-Mar-19	28-Mar-19	14	2049	2039.95	10.51056545	15.865
TCS	18-Mar-19	28-Mar-19	11	2030.5	2022.8	11.47876092	16.9
TCS	19-Mar-19	28-Mar-19	10	2033.7	2022.8	17.87150128	16.4925
TCS	20-Mar-19	28-Mar-19	9	2017.25	2015.05	4.024865953	16.0325
TCS	22-Mar-19	28-Mar-19	7	2009.8	2005.65	9.806485779	16.275
TCS	25-Mar-19	28-Mar-19	4	1988.35	1984.25	17.1374454	16.6725
TCS	26-Mar-19	28-Mar-19	3	1985.8	1982.65	17.57036168	16.485
TCS	27-Mar-19	28-Mar-19	2	1969.75	1967.9	15.59558866	17.0475
TCS	28-Mar-19	28-Mar-19	1	1996.2	2000.3	68.02520092	16.6525

Table 4.3

Symbol	Date	Expiry	Term to Expiry	FUT Adj. Closing Price	Spot Adj. Close Price	Annualised Return (%)	INDIA VIX
ITC	01-Mar-19	28-Mar-19	28	279.75	278.2	6.59928379	16.275
ITC	05-Mar-19	28-Mar-19	24	284	282.55	7.091842204	15.6575
ITC	06-Mar-19	28-Mar-19	23	286.6	285.75	4.290299429	15.61
ITC	07-Mar-19	28-Mar-19	22	291.8	290.1	8.833796497	15.2925
ITC	08-Mar-19	28-Mar-19	21	293.9	292	10.27530711	14.94
ITC	11-Mar-19	28-Mar-19	18	294.5	292.95	9.748931624	14.895
ITC	12-Mar-19	28-Mar-19	17	296.25	294.5	11.592296	15.0975
ITC	13-Mar-19	28-Mar-19	16	296.45	294.9	10.89506078	15.2775
ITC	14-Mar-19	28-Mar-19	15	296.8	295.5	9.727945548	15.15
ITC	15-Mar-19	28-Mar-19	14	292.25	290.8	11.8126932	15.865
ITC	18-Mar-19	28-Mar-19	11	295	293.75	12.83132954	16.9
ITC	19-Mar-19	28-Mar-19	10	300.85	299.45	15.50669883	16.4925
ITC	20-Mar-19	28-Mar-19	9	299.85	298.9	11.71466555	16.0325
ITC	22-Mar-19	28-Mar-19	7	298.75	298.2	8.741468088	16.275
ITC	25-Mar-19	28-Mar-19	4	295.6	295.05	15.46086073	16.6725
ITC	26-Mar-19	28-Mar-19	3	294.2	293.4	30.15096132	16.485
ITC	27-Mar-19	28-Mar-19	2	293.3	293.1	11.32028657	17.0475
ITC	28-Mar-19	28-Mar-19	1	299.45	300	60.84347391	16.6525

Table 4.4

4.2 Regression Analysis-

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.435361
R Square	0.189539
Adjusted R	0.177961
Standard E	11.56086
Observatic	72

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	2187.985	2187.985	16.37059	0.000132
Residual	70	9355.737	133.6534		
Total	71	11543.72			

	Coefficients	*tandard Erı*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-114.864	31.59798	-3.63516	0.000526	-177.884	-51.8436	-177.884	-51.8436
X Variable	8.02153	1.982554	4.046059	0.000132	4.067451	11.97561	4.067451	11.97561

Table 4.5 Regression Analysis

4.3 Data Used-

For the purpose of our analysis, we have used the Spot & Future Daily Adjusted Closing Prices of major Indian listed corporations like Reliance, HDFC Bank, TCS & ITC for the month of March,2019.

4.4 Variables-

- **FUT Adj. Closing Price-** Weighted average price of Future securities during the last 30 mins. of trading

- **Spot Adj. Closing Price-** Weighted average price of Spot market securities during the last 30 mins. of trading
- **India VIX**- The Volatility Index is an indicator of market sentiment for near-term volatility. Volatility is sometimes defined as the "rate & magnitude of price changes" and sometimes referred to as risk in the field of finance. The volatility index is an estimate of the degree by which the underlying index is anticipated to move in the short to medium term (calculated as annualized volatility, denoted in percentage e.g. 20 percent) based on the order book of the underlying index options.

  India VIX is an index of volatility based on the price of the NIFTY Index Options. A volatility figure (percentage) is computed from the best bid-ask prices of NIFTY Options contracts, which represents the anticipated market volatility over the next 30 calendar days. India VIX uses CBOE's computing technique, with necessary modifications to suit the NIFTY options order book using cubic splines, etc.

- **Term to Expiry**- Number of days left for the Futures contract to expire

- **Annualised Return (%)**- Yield from the Basis Arbitrage trade converted & expressed in annualized percentage return form

4.5 Finding-

Using Regression, we've found out a relation between Implied Volatility and Yield from Basis Arbitrage, which can be stated as:

$$\mathbf{Y = 8.02153*V - 114.864}$$

where,

Y – Yield from Basis Arbitrage

V – Implied Volatility

4.6 Analysis –

From the above found out relationship, we can see that Yield from a Basis Arbitrage increases with an increase in Implied Volatility, or vice- versa.

$$\boxed{\mathbf{Y \propto V}}$$

5. CONCLUSION

From our analysis of the data, we found out that the Yield from Basis Arbitrage is directly proportional with Market Volatility. That is, the returns from Arbitrage, involving simultaneous buying and selling of same security in Spot & Future segments, increases with an increase in Implied Volatility in the overall market, & vice-versa.

$$\mathbf{Y \alpha V}$$

This helps us in confirming that the long-held market perception of Yield from Arbitrage increases with an increase in Implied Volatility is true. This finding will also help other researchers and traders in future, for safely assuming this belief to be valid & scientific.

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With statistical backing of this relationship, the market participants (both Institutional Traders as well as Retail Traders) can safely develop their trading strategies to take advantage of pre-known events that cause high market volatility, such as Annual Budget, National Elections, US Presidential elections, Announcement of Corporate Results, etc.

But, traders must remain careful while trading and should not solely rely on the above equation for computing the expected yields, since the yield would also depend on variables other than Volatility. The above equation can be used as one of the indicator/tool while trading & has been calculated for establishing a relationship between Yield from Arbitrage and Implied Volatility, & not for indicating in any way that the Implied Volatility is the only factor affecting Yield.

For summarising the conclusion, we can state that:

1. We fail to reject the Null Hypothesis.
2. We can safely deduce from our Research that the Yield from Basis Arbitrage is directly proportional to Volatility.

6. REFERENCES

1. Research Gate (researchgate.net)
2. International Journal Corner (internationaljournalcorner.com)
3. IIM Calcutta Publications (iimcal.ac.in)
4. International Business Times (ibtimes.com)
5. Information & Library Network Centre (inflibnet.ac.in)
6. *'Arbitrage opportunities in the futures market: A study on NSE NIFTY 50'* by Dr.R.Kannan, Dr.Sangeeta Mishra, Dr.Dheeraj Mishra (2006)
7. *'DAX index Futures: Mispricing and Arbitrage in German Markets'* by Wolfgang Buhler and Alexander Kempf (1995)
8. *'Price discovery and arbitrage efficiency of Indian equity futures and cash markets'* by Dr. Balwinder Singh (2008)
9. *'Index Arbitrage between Futures and ETFs: Evidence on the limits to arbitrage from S&P 500 futures and SPDRs'* by Nivine Richie and Robert Daogler (2008)
10. NSE-National Stock Exchange of India (nseindia.com)
11. International Business Times (ibtimes.com)
12. Taylor Francis Online (tandfonline.com)