Tracking Error and Pricing Efficiency of Exchange traded funds during the phases of Lockdown Evidence from Indian ETFs

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By

ROHIT SATAPPA HOSAMANI

Roll Number: 12

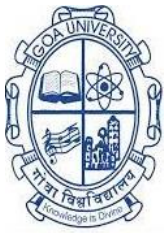
Under the Supervision of

Dr. PRACHI KOLAMKER

Assistant professor

Goa Business School

MBA (FINANCIAL SERVICES)



GOA UNIVERSITY

DATE: MAY 2023

Examined by: Seal of the School

DECLARATION BY STUDENT

I hereby declare that the data presented in this Project report entitled, "Tracking Error and Pricing Efficiency of Exchange traded fund during the phases of Lockdown Evidence from Indian ETF" is based on the results of investigations carried out by me in the (MBA in financial services) at the Goa Business School, Goa University under the Mentorship of Dr. Prachi Kolamker and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will be not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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Rohit Satappa Hosamani
12- 2021
MBA Financial Services
Goa Business School

Date:

Place: Goa University

COMPLETION CERTIFICATE

This is to certify that the dissertation / internship report "Tracking Error and Pricing Efficiency of Exchange traded fund during the phases of Lockdown Evidence from Indian ETF" is a bonafide work carried out by **Mr. Rohit Satappa Hosamani** under my mentorship in partial fulfilment of the requirements for the award of the degree of **Masters in Business Administration** in the Discipline **Financial Services** at the Goa Business School, Goa University.

Date:

Dr. Prachi Kolamker
MBA (Financial Services)

Prof. Jyoti D Pawar
Computer science and technology
Name of School
Date:
Place: Goa University

School Stamp

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LIST OF ABRIVATION

NSE	National Stock Exchange
ADF	Augmented Dickey fuller
AUM	Asset under management
AMFI	Association of Mutual fund of India
NAV	Net Asset value
APs	Authorized participant
ETF	Exchange traded funds

CHAPTER 1

INTRODUCTION

1.1 Introduction:

Passive investing through exchange traded funds (ETFs) has emerged as a significant trend in global investing. The launch of the first ETF, "NiftyBees," in 2001 marked the beginning of the growth of passive equity assets in India, which reached nearly $20 billion in 2019, accounting for 18% of the equity fund industry **(Ramachandran & Saha, 2020).** ETFs have become increasingly popular among investors due to their ability to provide exposure to a broad range of markets and asset classes.

Exchange Traded Funds (ETFs) is a form of indexing that attempts to provide the dual advantages of investing in mutual funds as well as stocks and sector **(Kaur & Singh, 2018).** Similar to mutual funds, they help diversify risk through investment in multiple stocks, helps to take advantage of real-time trading opportunities in the market. ETFs invest their entire corpus of funds in the constituents of the index that they aim to track.

ETFs hold assets such as stocks, commodities, or bonds, and trade close to their net asset value (NAV) and stock prices throughout the day. ETFs can track a specific index, a particular sector of an industry, or even the stock markets of a foreign country **(S. Narend 2014).** They offer several advantages over traditional mutual funds, such as lower expense ratios, trading flexibility, tax efficiency, transparency, and exposure to diverse asset classes. Market makers play a vital role in the creation and redemption of commodity ETFs by buying the underlying commodity from the market and get it exchanged for the ETF units from the funnd house custodian.

Tracking error:

ETFs, tracking error is typically defined as the deviation of the return on the NAV of an ETF from the corresponding return on its underlying benchmark index. (Narat Charupat and Peter Miu 2012) unlike price deviations, which are typically expected to be within the arbitrage bounds given the creation/redemption process of ETFs (as examined above), any deviations of the returns on NAV from those of their underlying benchmarks.

Pricing efficiency:

One unique feature of ETFs is the creation/redemption process, under which select traders can purchase (sell) large lots (or creation units) of an ETF directly from the fund issuer at the NAV. Depending on the ETFs, the purchase and sale are done in kind (i.e. using basket of securities comprising the underlying benchmarks) or in cash. **(Narat Charupat and Peter Miu 2012)** Generally, ETFs that hold the constituent stocks of

their underlying indices will use an in-kind process, while ETFs that use derivative securities to replicate the underlying returns will use an in-cash process.

Creation and redemption:

(Petajisto 2017) highlights the transmission channel for the cascading effect of the premium on the ETF creation and redemption process. When any ETF with a premium (discount) is identified, APs will intervene and create (redeem) ETF units. This arbitrage process induces sell (buy) pressure for ETFs and hence reduces the premium (discount). We measure creation as a percentage of the average daily trading volume of ETF. Negative creation is termed redemption.

1.2 Literature review:

ETF pricing efficiency:

The ETFs, on average, outperform their fund benchmarks, but the magnitudes of the premium (discount) and tracking error are considerably higher for a synchronously traded market examines the pricing efficiency of domestic exchange-traded funds (ETFs) in the Indian equity market where growth co-exists with operating inefficiencies the study found that nonsignificant negative relationship between discount and redemption units, implying that the creation/redemption process remains unaffected by the prevailing discount in the market. Despite low arbitrage constraints, market participants fail to curtail the prevailing tracking error and discount. This study highlights the operational constraints of arbitrageurs in the Indian ETF market **(Garima Goela,, Eshan Ahluwalia 2021).** Studies ETFs in bullish and bearish market condition using high occurrence data for a period of seven years the author found that the tracking error found to be relatively high in bearish conditions. The average premium is higher in bearish markets characterized with highest volatility. On the other hand, the average discount is higher in bullish markets characterized with least volatility. The price difference "depart" within three days and the market price and the fund's net asset value (NAV) get aligned due to arbitrage mechanism **(R. Shanmugham Zabiulla 2012).** The pricing efficiency of Indian equity ETFs attempts to understand the lead-lag relationship between the price and NAV The author concluded that the presence of deviation between the market price and NAV of ETF for more than one day represents an supplementary cost to the investors, but also provides arbitragers with an opportunity to book low-risk profi**t (Y V Reddy, 2020)**. Studies and investigates the pricing efficiency of World Indices Exchange Traded Funds (ETFs) traded on the National Stock Exchange (NSE) of India. Additionally, an attempt has been made to understand the price discovery mechanism between Price and NAV of ETFs through Vector Error Correction Model (VECM) **(Ashima Gaba and Ravinder Kumar)** Investigates the tracking and pricing efficiencies of selected exchange traded fund (ETF) in India found that NAVs lead their respective market prices indicating huge

scope for arbitrage opportunities to authorized participants. Persistence in the deviation between NAVs and market prices is prevalent for longer period, indicating inefficient price discovery mechanism of Indian ETF market. The study confirms market inefficiency in Indian ETF market. **(VDMV Lakshmi 2022).**

Determinant of ETF tracing efficiency:

Explore the factors that affect the tracking efficiency of ETFs while considering investment in ETFs, should not only consider the expense ratio but should also look upon other variables that drastically enhance or diminish the tracking efficiency of ETFs **(Jaspal Singh Prabhdeep Kaur 2018).** Supporting to the determinant another paper investigates how efficiently India-domiciled exchange traded funds (ETFs) replicate the returns of their underlying indices and analyses the factors that determine the tracking performance of the sample ETFs is extensively not as good as in comparison with their counterparts in more developed regions. The ETF-index disequilibrium has been found to be quite persistent in the short run, implying that tracking ineffectiveness is not only large but also non-transitory **(Vanita Tripathi and Aakanksha Sethi 2021).** In contrast to the similar paper studies commodity Gold ETF the performance of gold ETF in bullish and bearish market was studied testing whether ETFs' sensitivity to their respective underlying indices varies across the two market regimes and also explore factors that affect the short-run tracking efficiency of ETFs the author found higher beta coefficient observed during the market up trends further indicates higher tracking efficiency of gold ETFs during the bullish market regime. And also finds that liquidity (volume) of an ETF plays a vital role in its ability to mimic its underlying asset. Noise trading (volatility) and imperfect arbitrage mechanism (pricing deviation) exert a negative influence on the tracking ability of ETFs.

ETF tracking error:

The evaluation of the performance of sample ETF's through risk-return analysis, risk-adjusted performance measures, tracking error analysis and multi-factor regression have revealed that the majority of the sample ETF's outperformed their tracking indices but with notable tracking errors during the study period. Further, the study also indicates that the returns of the sample ETF's have a significant and positive relationship with the returns of the index but are inversely related to risk and management fees **(Alamelu Nisha Goyal 2022).** Apart from the Indian market, there have been studies conducted in foreign stock market to examine factors and determinants related to tracking error and tracking efficiency, such as the significance and magnitude of tracking error in ETFs. The author of these studies suggest that when considering investing in ETFs one should not only focus on the expense ratio, but also consider other variables that can significantly impact the tracking efficiency of ETFS **(Jaspal Singh Prabhdeep Kaur 2018).** Another similar study of magnitude as a determinant studied from Hong Kong stock market

studies the tracking error and compares performance with developed market the author concludes that the tracking errors are comparatively higher than those documented in US and Australia. The magnitude of the tracking errors is also found to be negatively related to the size but positively related to the expense ratios of the funds, which are consistent with the previous studies **(Patrick Kuok-Kun Chu 2011).** Tracking error appears to be higher in emerging markets when compared to developed markets. Furthermore, tracking error was found to be relatively higher in bearish conditions for developed markets, while this was quite the opposite in different emerging markets **(Augusto Ferreira da Costa Neto, Marcelo Cabús Klötzle and Antonio Carlos Figueiredo Pinto 2021).** Daily tracking performance is very poor the author suggests that these ETFs are not vehicles for very active trading (e.g. day trading or high-frequency trading). For the ETF provider, our results may provide some guidance on where improvements in terms of tracking performance and TE may be possible. In fact, Smartshares has already put some measures into place in an attempt to reduce TE. Specifically, Smartshares, very recently, introduced dedicated market making in its ETFs to improve liquidity and decrease spreads **(Jun Chen, Yi Chen and Bart Frijns 2017).**

1.3 Research gap:

Through the literature review we observed that most of the studies on ETFs tracking error, and pricing efficiency, are made by developed market still there is a need to study about the ETF in emerging market. However there is a limited evidence of such studies in Indian context. The study attempts to fill the gap by studying the ETFs tracking error and pricing efficiency with the help of select ETFs for the periods of covid lockdown ie pre, during and post lockdown.

1.4 Objective of the study:

1) To examine the tracking error of select ETF's in India during the phases of lockdown.

2) To study the pricing efficiency and price discovery of select ETF's in India during the phases of lockdown.

1.5 Scope of the study:

To examine the tracking error and Pricing efficiency of Exchange traded funds in the Lockdown phases and also to study premium pricing and discount pricing this study is useful for Market makers APs (Authorised participant) and investors where during such

crises one can enjoy the market correction where the pricing is at discount the Authorised Participant who has a basket of ETFs for the supply of creation and Redemption. The study will help AP's to understand the supply of ETF in the market during such market situations.

1.6 Research Methodology:

Period of study:

For the purpose of this study, the study contains daily closing prices of select ETF for last 5 years. This is from pre and post covid19 pandemic (2018-2022).

- Pre-covid19 (1st January 2018 to 21st March 2020).
- During covid19 (21st March 2020 to 31st December 2021).
- Post covid19 (31st December 2021 to 31st December 2022).

Sample design:

The sample contains three types ETFs that are Equity, sector and commodity ETF sourced from NSE website.

Table 1: Selected ETFs overview:

Sr.no	Fund name	Issuer	Underlying asset	AUM asset under management
EQUITY ETF				
1	Nippon India ETF Nifty BeES	Nippon India AMC	Nifty 50 index	11550.86 Cr
2	HDFC NIFTY 50 ETF	HDFC AMC	Nifty 50 index	1948.07 Cr
3	Kotak Nifty 50 ETF	Kotak AMC	Nifty 50 index	1956 Cr
4	UTI Sensex ETF	UTI AMC	S&P BSE Sensex	26577.96 Cr
5	SBI S&P BSE SENSEX ETF	SBI AMC	S&P BSE Sensex	83893.22 Cr
6	HDFC S&P BSE Sensex ETF	HDFC AMC	S&P BSE Sensex	306.65 Cr
SECTOR ETF				
1	Nippon India ETF Nifty Bank BeES	Nippon India AMC	Nifty bank	6189 Cr
2	Kotak Nifty Bank ETF	Kotak AMC	Nifty bank	4418.28 Cr

3	Nippon India ETF Nifty India consumption	Nippon India AMC	Nifty India consumption	40.88 Cr
4	Nippon India ETF Nifty infrastructure BeES	Nippon India AMC	Nifty infrastructure	35 Cr
GOLD ETF				
1	Nippon India ETF gold BeES	Nippon India AMC	Gold	7203.19 Cr
2	HDFC gold ETF	HDFC AMC	Gold	3353.14 Cr
3	SBI gold ETF	SBI AMC	Gold	3059.78 Cr

DATA SOURCE:

The study considers secondary data, of three asset class of ETFs such as equity ETFs, sector ETFs and commodity ETFs traded on Exchange. The three asset class considers tracking indexes of BSE S&P BSE Sensex Total Return Index (TRI) is the benchmark index. National stock exchange for which the benchmark index is NIFTY 50 TRI, Nifty bank TRI, Nifty consumption TRI, Nifty infrastructure TRI Gold index the daily market prices of the select ETFs and their respective benchmarks have been sourced from the website of NSE and Moneycontrol. NAVs of ETFs have been collected from the website of respective Association of mutual funds India AMFI The sample period we have taken is during pre, post and during covid pandemic that is from 2018 to 2022.

- Pre-covid19 (1st January 2018 to 21st March 2020).
- During covid19 (21st March 2020 to 31st December 2021).
- Post covid19 (31st December 2021 to 31st December 2022).

1.7 Tools and Techniques:

Summary Statistics:

Summary statistics are used to gain insight into the nature of the variables. Mean, standard deviation, skewness, and kurtosis are commonly used measure to analyze data. Mean is the most popular measure of central tendency, which is the mathematical average of a series of measures. Standard deviation measures the dispersion of data in a set a low standard deviation indicates that value do not vary much from the mean. Skewness measures the symmetry in distribution, and kurtosis determines how heavily the trails of a distribution differ from the normal distribution trails. Together, skewness and kurtosis can provide insight into the shape of the distribution of a dataset.

Test of Stationarity:

The study uses the Augmented Dickey-Fuller test (ADF) to check unit root presence in the time series. A unit root test is used to determine whether the time series is nonstationary and has a unit root. Which cause a systematic pattern that is unpredictable. The ADF test tests the null hypothesis that a unit root is present in the time series, meaning it is nonstationary, and the alternative hypothesis that the time series is stationary. Stationary time series have a constant mean and variance regardless of when they are measured, making them time-invariant.

Auto-regression model

The autoregression model is a statistical model that predicts a variable's future value using past values of the same variable. It does this by using a linear combination of the variable's previous values, hence the term "autoregression" or regression of self. The model is represented mathematically as an equation where the current value of the variable is equal to a constant plus the sum of the product of the variable's past values and corresponding coefficients. The order of the autoregression model, denoted by "p", indicates the number of past values used to predict the current value.

Johansen cointegration test

The Johansen cointegration test investigates the relationships between multiple non-stationary time series and tests for cointegration, indicating a long-term equilibrium relationship and movement together resulting in a stationary time series with a shared underlying trend. The MLE approach is used to determine the validity of these relationships. The test assumes a null hypothesis that no cointegrating equations exist and an alternative hypothesis that at least one cointegrating relationship exists.

Vector error correction model

This research utilizes a statistical model called Vector Error Correction Model (VECM) to study the relationship between multiple variables over time. VECM is a type of Vector Autoregression (VAR) that is suitable for analyzing nonstationary series that are cointegrated. Cointegration relations are used in VECM to constrain the long-term behavior of endogenous variables to converge to their cointegrating relationships while allowing for short-term adjustments. The error correction term in VECM helps to gradually correct deviations from long-term equilibrium through a series of partial short-term adjustments. The error correction coefficient in VECM provides information about the efficiency of a variable in reaching long-term equilibrium, with a lower error coefficient indicating greater efficiency. The variable with a lower error coefficient leads and reaches the equilibrium point before the other variable. The past information of the leading variable can be used to predict the timing of the lag variable.

1.8 Limitation of the study:

For this study we have taken the covid crisis in our study by studying how Exchange traded funds have performed during lockdown phases. There are number of different types listed ETF from which we have considered only three assest class of ETF such as equity, sector and commodity gold ETFs. Sample ETF are taken on the bases of higher AUM (Asset under management). Listed on stock exchange where we have limited the study to ETF tracking error, pricing efficiency and price discovery in Indian context. One can consider more and different asset class of ETF and can also consider other crises in the market for study.

1.9 Chapterisation:

Chapter 1: Introduction, literature review research gap, objective, scope of the study, research and methodology and limitation of the study.

Chapter 2: Data analysis and interpretation, summery statistics, stationarity test, unit root test, Auto regression analysis, Johansens cointegration test, vector error correction model.

Chapter 3: Summerizes the findings based on which conclusions are drawn.

CHAPTER 2

2.1 DATA ANALYSIS AND INTERPRETATION:

OBJECTIVE 1: To examine the tracking error of select ETF's in India during the lockdown phases.

OBJECTIVE 2: To study the pricing efficiency of select ETF's in India during the lockdown phases.

2.2 Methodology:

OBJECTIVE 1: To examine the tracking error of select ETF's in India during the lockdown phases.

To examine whether the tracking error was favorable during the lockdown for the investors and also to know how tracking performance was efficient. To examine examine tracking error the period of study undertaken is five year daily data from 2018 to 2022 and the date was classified by considering phases of lockdown the data were sourced from NSE National stock exchange and Yahoo finance websites. ETF returns and tracking indices returns were calculated with the help of MS Excel.

Tracking Error:
The tracking error is a measure of the difference between the returns of an index fund and its target index, calculated as the annualized standard deviation of the return difference. It indicates how closely a fund's returns match those of the index. A lower tracking error means that the fund's returns are closer to the index, and a higher tracking error indicates greater divergence. Studies on developed markets have shown that index mutual funds and ETFs have similar tracking error records. Factors that influence the tracking error of an index fund include transaction costs, benchmark volatility, fund cash flows, and changes in the index composition. These factors can increase the tracking error and emphasize the importance of fund managers minimizing it. The measurement of tracking error is similar to the methodology used by various studies, including Yadav and Pope (1994), Frino and Gallagher (2001), and Narend and Scholar (2014).

(1) $$\boldsymbol{TE = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}(e\,fund - eindex)^2}}$$

Where $efund$ represent the returns of the index fund and $eindex$ represents the returns of the fund's underlying benchmark index. The daily tracking error was computed and then annualized for index funds.

Summery Statistics

To analyze and understand the nature of variables, summary statistics such as mean, standard deviation, skewness, and kurtosis are used. The mean is a widely used measure

of central tendency and is the mathematical average of a series of measures obtained by dividing their sum by their number. Standard deviation is a common measure of the dispersion of a series and indicates the extent of variation in the data set. A low standard deviation implies that the values in the set do not differ significantly from the mean. Skewness measures the symmetry in distribution and is determined by β1. If β1 is equal to 0, the data set is symmetrical. If β1 is more than 1, the distribution is positively skewed, and if β1 is less than 1, it is negatively skewed. Kurtosis is a statistical measure that identifies the heaviness of the tails of a distribution relative to those of a normal distribution. It determines whether a distribution contains extreme values. Skewness measures the symmetry of the distribution, while kurtosis determines the heaviness of the distribution tails.

TABLE2:Summery statistic of tracking error during Pre lockdown

ETFs	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
HDFC Gold ETF	-0.01184	0.025818	9.653818	-9.65763	1.856699	-0.04074	7.181989
Nippon India ETF gold BeES ETF	-0.0118	0.025818	9.653818	-9.65763	1.856704	-0.04081	7.181973
SBI gold ETF	-0.02361	0.033542	7.003424	-9.55251	1.279459	-0.37686	12.86854
HDFC S&P BSE Sensex ETF	0.156685	0.154215	8.97784	-5.75363	1.342802	0.817711	10.73251
HDFC Nifty 50 ETF	0.029675	-0.01317	8.531603	-5.77336	1.323107	0.806436	10.92682
Kotak Nifty Bank ETF	0.076908	0.043833	9.983324	-7.9839	1.610413	0.422036	9.391877
Kotak Nifty 50 ETF	0.156225	0.153802	8.977121	-5.75866	1.342884	0.816599	10.73137
Nippon India ETF nifty BeES	0.15663	0.154096	8.977585	-5.75645	1.342848	0.81706	10.73139
Nippon India ETF bank BeES ETF	0.060516	0.040457	9.918186	-8.13844	1.335731	0.502892	14.21661
Nippon India ETF infrastructure BeES	0.076946	0.043833	9.983324	-7.9839	1.610389	0.42185	9.391702
Nippon India ETF Nifty consumtion ETF	0.085094	0.04483	8.446771	-6.88761	1.482901	0.127676	7.60253
SBI S&P BSE Sensex ETF	0.029615	-0.01317	8.531603	-5.78141	1.323868	0.804682	10.91324
UTI S&P BSE Sensex ETF	0.029618	-0.01317	8.531603	-5.78121	1.323875	0.804711	10.91314

Sources: Eviews 9

The Summery statistics of ETFs' tracking error are reported in Table 2 Presented are the tracking error of the sample, the standard deviation of the sample's estimated tracking error records, the median tracking error, the minimum and maximum tracking errors and the coefficients of skewness and kurtosis. The statistics are presented on daily basis. Moreover, tracking errors are combined in price return and NAV return terms. According to the results of pre lockdown period, the average tracking error of the sample is above 1

percent for pre lockdown thus the ETFs could not beat the underlying index returns. The tracking error was not efficient during pre lockdown period.

TABLE 2(a): Summery statistic of Tracking Error During lockdown

ETFs	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
HDFC Gold ETF	0.005619	-0.00693	6.309193	-11.00966	1.636189	-0.467108	8.493962
Nippon India ETF goldbees ETF	-0.00276	0.001823	7.645979	-8.347305	1.811225	-0.210714	5.386193
SBI gold ETF	-0.50873	-0.01287	6.308623	-233.6811	11.22139	-20.32006	422.7509
HDFC S&P BSE Sensex ETF	0.011625	0.000497	10.2343	-15.4053	2.578678	-0.345551	6.771835
HDFC Nifty 50 ETF	0.013409	-0.0088	5.11555	-5.233795	1.398579	-0.044026	4.373745
Kotak Nifty Bank ETF	0.009039	-0.01761	6.616668	-7.057997	1.617305	0.129319	4.567984
Kotak Nifty 50 ETF	-0.0024	0.001854	7.644832	-8.345513	1.811454	-0.21056	5.382888
Nippon IndiaETF niftybees	0.012001	0.001874	10.23315	-15.40351	2.579142	-0.345816	6.766881
Nippon India ETF bank BeES ETF	0.00418	0.006783	4.921806	-6.184849	1.357351	-0.248857	5.239495
Nippon India infrastructurebees ETF	0.005594	-0.00691	6.308935	-11.00973	1.636721	-0.468085	8.48493
Nippon India ETF consumption BeES	-0.50962	-0.00821	5.86367	-233.4846	11.23335	-20.29565	421.4409
SBI S&P BSE Sensex ETF	0.01222	-0.00194	5.861954	-10.48094	1.604011	-0.424318	8.079365
UTI S&P BSE Sensex ETF	0.012528	-0.0042	5.863172	-10.47737	1.603814	-0.423638	8.073202

Sources: Eviews 9

The summery statistics of ETFs' tracking error are reported in Table 2a Presented are the tracking error of the sample, the standard deviation of the sample's estimated tracking error records, the median tracking error, the minimum and maximum tracking errors and the coefficients of skewness and kurtosis. The statistics are presented on daily basis Moreover, tracking errors are computed both in price return and NAV return terms. According to the results during lockdown period the average tracking error of the sample is Abow 1 percent during lockdown. The tracking error was not efficient in during lockdown period thus the ETF could not beat the underlying index return.

TABLE 2(b): Descriptive Statistics of Tracking Error Post lockdown

ETFs	Mean	Median	maximum	minimum	Std.	vness	tosis
HDFC Gold ETF	0.040998	0.009352	3.341812	-3.4236	1.02028	-0.03513	3.814784
Nippon India goldbees	0.005157	0.002025	1.861128	-1.74971	0.288542	-0.15505	16.37722
SBI gold ETF	0.008119	0.017232	4.113932	-2.12324	0.574608	1.325859	12.28514
HDFC S&P BSE Sensex ETF	-0.00935	0.012005	2.105155	-4.30237	0.795706	-0.84539	6.678637
HDFC Nifty 50 ETF	0.003498	0.002649	3.626359	-2.80945	0.8105	0.227323	6.123593
Kotak Nifty Bank ETF	-0.00429	-0.01838	3.795986	-4.50096	0.848262	-0.26187	8.230533
Kotak Nifty 50 ETF	0.040104	-0.02775	3.437477	-2.79595	1.038508	0.093945	3.835112
Nippon India niftybees	0.004361	0.005299	1.213818	-1.10839	0.170439	0.262558	19.00866
Nippon India ETF bank	0.040047	0.022108	6.438637	-5.76639	1.139074	0.279346	9.251498
Nippon India infrabees	0.007673	0.008268	3.882275	-2.03605	0.576308	1.1468	11.20469
Nippon India consumer	-0.17157	-0.19132	6.238829	-8.54789	1.541217	-0.47553	7.700094
SBI S&P BSE Sensex	-0.0008	-0.00271	1.065886	-0.87461	0.202404	0.131089	7.058036
UTI S&P BSE Sensex	0.002617	0.000202	1.164392	-1.14022	0.177209	0.094285	16.04231

Sources: Eviews 9

The summery statistics of ETFs' tracking error are reported in Table 2b Presented are tracking error of the sample, the standard deviation of the sample's estimated tracking error records, the median tracking error, the minimum and maximum tracking errors and the coefficients of skewness and kurtosis. The statistics are presented on daily basis. Moreover, tracking errors are computed both in price return and NAV return terms. According to the results of post lockdown period the average tracking error of the sample is below 1 percent post lockdown that shows that there is improvement in ETFs tracking error.

2.3 Methodology:

OBJECTIVE 2: To study the pricing efficiency of select ETF's in India during lockdown phases.

The basic purpose of the study is to see how India ETFs pricing and price discovery was efficient during the phases of lockdown by studying the pricing efficiency. The data used in this study is secondary data where some data were converted to returns, and pricing deviation, in Excel file using formulas. The period of study undertaken is five years daily data from 2018 to 2022 and the data were classified by considering phases of lockdown during covid pandemic types of tools and techniques used for the study are Summary statistics, Augmented Dickey Fuller (ADF), Auto regression analysis, Unit Root test, Johansens cointegration test and VECM model.

Premium/Discount, Arbitrage, and Pricing Efficiency:

If an ETF's market price is higher than its NAV, it's considered to be trading at a premium, while a lower market price than NAV means it's trading at a discount. This price difference can have significant consequences for investors since buying overpriced ETF shares or selling undervalued ones can lead to a cost. The speed at which Authorized Participants (AP) correct deviations between ETF NAV and market price is called pricing efficiency. A highly efficient market results in greater liquidity, lower transaction costs, and fewer restrictions, contributing to price discovery into the stock market index and its derivatives. Therefore, this study aims to analyze the pricing efficiency of Indian ETFs using an autoregression model over price deviation and exploring the lead-lag relationship between ETF price and NAV through the vector error correction model (VECM).

To prepare the data for analysis, missing values were addressed, and a price deviation series was computed by taking the difference between the daily closing price of an ETF and its corresponding daily NAV. This series will be used for further research purposes.

To evaluate the pricing efficiency of ETFs, the study examined the persistence of arbitrage, which involves exploiting price differences through simultaneous buying and selling of securities. The existence of arbitrage was indicated by the deviation between the market price of an ETF and its NAV.

$D = p_t - NAV_t$

Where,
D= price deviation
p_t = closing price of the ETF and,

If D is negative, the fund is said to be trading at a discount to its NAV and, at a premium, if it is contrary.

Initially, we used summary statistics to examine and comprehend the characteristics of the price deviation series we obtained. The summary statistics included the number of observations for each ETF, the average deviation amount, the minimum and maximum deviation amounts, the standard deviation, skewness, and kurtosis of the data series. The average deviation denotes the typical price deviation throughout the period. The standard deviation assesses the degree of variation in the dataset. A smaller standard deviation implies that the values are not significantly different from the dataset's average and is advantageous for the study. Skewness measures the distribution's symmetry, where a value of 0 indicates that the dataset is symmetrical, a value greater than 1 indicates a positive skewness, and a value less than 1 indicates a negative skewness. Kurtosis is a statistical measure that measures the tails of the distribution's heaviness and how they differ from a normal distribution. While skewness determines the symmetry of the distribution, kurtosis determines the distribution tails' thickness.

Given that our dataset is in the form of a time series, we employed the Augmented Dickey-Fuller (ADF) test to assess whether the deviation series is stationary or non-stationary. In case a time series contains a unit root, it follows a predictable pattern that can result in unpredictable consequences. To validate this, we established the null hypothesis as: H3a: The price deviation series exhibits a unit root.

In order to assess the degree of persistence in premium/discount, the premium/discount series, which represents the difference between the closing price and NAV, was subjected to regression analysis against its lagged value. The equation utilized for this purpose is provided below.

$$D = \Phi 0 + \Phi 1\ Dt\text{-}1 + \varepsilon t$$

An inconsequential value for Φ1 indicates that the premium or discount does not persist and disappears within one trading day. A significant value would suggest that deviation persists and can be grasped advantage of by the investors. The continuity of deviation was analyzed using an autoregression model and by adjoining additional lagged values of the captured price deviation as the explanatory variable (Charteris, 2013; Kayali, 2007). Here are two lags that is as follows.

We used the equation $D = \Phi 0 + \Phi 1\ Dt\text{-}1 + \Phi 2\ Dt\text{-}2$, etc. to measure the persistence of premium/discount. The AP of the fund is responsible for creating and deleting ETF units in the primary market, which should eliminate any premium/discount within one trading day. If the deviation persists for more than one day, investors can benefit from these differences (Charteris, 2013). Thus, the null hypothesis formulated is as follows:
H3a: The persistence of arbitrage for Indian ETFs does not disappear within a day.

Johansen co-integration test:
The study conducted a Johansen co-integration test and found a co-integration relationship between the two price series, using the Akaike information criteria for order

lag selection. The price and NAV variables were transformed into their log form to correct the trend, and no-constant and no-trend models were used in the cointegration tests. To examine long-term co-integration, the null hypothesis was formulated as follows:
H4: There is no long-run relationship between the market price and NAV of ETFs.

Vector Error Correction Model:
The study employed VECM analysis to investigate the short-term dynamics between the integrated variables. Using the Johansen co-integration test, the presence of a cointegrating vector between the market price and NAV was established before applying the VECM to identify the lead and lag indicators among NAV and market price. The price discovery process, which adheres to the Law of One Price (LOOP), determines how the market price and NAV return to equilibrium. The VECM provides the error correction coefficient for both market price and NAV, where a higher coefficient signifies a larger deviation from long-run equilibrium, and a lower coefficient indicates more efficiency in achieving long-run equilibrium and leads to the subsequent variable. The variable with the lower error coefficient is the lead indicator and reaches equilibrium well before the other variable. Hence, the historical information of the lead variable can be effectively used to predict the lag variable's moment. To test this, the following null hypothesis was formulated:
H5: The historical information of NAV cannot predict the future price discovery of ETF.

Table 3: Summary statistics pre lockdown price deviation of ETFs

ETFs	Observations	Mean	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis
HDFC gold ETF	544	-39.3422	74.03465	-435.7406	239.541	-1.37913	6.999009
SBIGOLD ETF	545	-3029.72	357.2793	-4008.394	9.7122	0.347163	11.56195
HDFC S&P BSE Sensex etf	544	18.35454	145.6772	-232.5501	1125.99	3.753516	24.442
Kotak bank ETF	545	-2.08718	4.778686	-38.7177	30.0011	-0.15541	18.26025
Nippon india ETF consumption	545	0.126432	0.59683	-3.1462	4.3345	1.58075	14.3947
Nippon india infra etf	545	0.390058	4.455341	-25.8037	33.7556	1.341465	15.5142
nippon india goldbees	545	-31.6928	202.6426	-3325.113	42.8633	-15.7644	256.1304
HDFC Nifty ETF	545	2.697229	20.78652	-54.86	286.99	7.72921	89.63941
Kotak nifty 50 etf	545	-59.8256	4.068694	-68.7221	-43.7234	-0.10296	3.349342
nippon india niftybees etf	545	-924.604	336.1452	-1287.28	6.389602	2.308741	6.588288
nippon india bank etf	545	-47.925	374.9111	-2975.72	95.4322	-7.53483	58.06387
SBI S&P BSE Sensex etf	544	2.437948	15.2546	-54.8173	124.3608	3.586382	26.45554

UTI S&P BSE SENSEX ETF	545	2.854955	6.512932	-8.065612	54.3031	3.906936	25.84561

Sources: Eviews 9

Presents the summary statistics of the price deviation series of the selected ETFs. The measure of performance herein is used to indicate the average price deviation of the respective ETF. The mean value signifies, on average six ETFs trade at a premium and the remaining seven at discount. The standard deviation reflects the variation in data over a period of time. During the pre lockdown, the lowest deviation of RS -4008.39 was reported for SBI Gold and the highest deviation of Rs 1125.99 was reported for HDFC S&P BSE Sensex etf.

Table 3 (a): Results of summary statistics during lockdown price deviation of ETFs

	Observations	Mean	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis
HDFC gold ETF	497	-2272.89	2187.058	-4940.96	423.2279	0.050397	1.019539
SBIGOLD ETF	497	-4277.73	189.3492	-4946.95	-3656.65	-0.60518	3.873023
HDFC S&P BSE Sensex etf	497	-1933.97	1862.452	-5027.23	632.84	-0.07914	1.276402
Kotak nifty bank ETF	497	-25.4095	128.394	-416.441	101.965	-2.25895	6.600673
Nippon India ETF consumption	497	-4.71613	25.79103	-81.6183	14.576	-2.38952	6.915631
Nipponlindia ETF infrastructure BeES	497	-29.9153	175.677	-552.564	91.0204	-2.41918	7.069524
Nippon India ETF goldbees	497	-4.63656	13.26039	-42.9575	8.1156	-2.35069	6.801681
HDFC Nifty 50 ETF	497	-348.355	558.8411	-1463.59	251.39	-0.87555	1.94807
Kotak nifty 50 etf	497	-73.4551	41.54571	-194.357	-35.5258	-2.06078	5.98214
nippon India ETF niftybees etf	497	-10.9391	63.72759	-199.087	32.4904	-2.40465	6.955321
Nippon India ETF bank BeES	497	-21.4685	129.283	-415.201	103.3069	-2.26686	6.623544
SBI S&P BSE Sensex etf	497	-38.9399	208.3534	-650.788	107.2957	-2.38531	6.898369
UTI S&P BSE SENSEX ETF	497	-34.7257	208.5606	-646.71	112.447	-2.3813	6.885833

Sources: Eviews 9

Presents the summary statistics of the price deviation series of the selected ETFs. The measure of performance herein is used to indicate the average price deviation of the respective ETF. The mean value of all select ETFs is traded at discount. The standard deviation reflects the variation in data over a period of time. During lockdown, the lowest deviation of RS -5027.23 was reported for HDFC S&P BSE Sensex ETF and the highest deviation of Rs 632.84 was reported for HDFC S&P BSE Sensex etf.

Table 3 (b): Results of summary statistics Post lockdown price deviation in ETFs

ETFs	Observations	Mean	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis
HDFC gold ETF	247	-0.35313	0.579375	-2.4737	0.9866	-0.64914	4.251499
SBIGOLD ETF	247	-86.3417	597.4055	-4258.94	0.6069	-6.81369	47.42832
HDFC S&P BSE Sensex etf	247	-40.2325	167.5098	-681.039	82.24002	-3.37918	12.83578
Kotak bank ETF	247	-4.10819	4.181319	-33.9117	5.2754	-2.91696	17.73152
Nippon India ETF consumption	247	0.110962	0.359503	-1.1504	2.5682	1.618481	14.33948
Nippon India ETF infrastructure BeES	247	0.500047	2.383627	-6.4261	14.8095	1.327299	11.87701
Nippon India ETF goldbees	247	-0.30077	0.334544	-1.8432	0.5114	-1.53155	6.427195
HDFC Nifty ETF	247	0.144133	0.815552	-3.76	3.85	-0.27808	8.431794
Kotak nifty 50 etf	247	-85.9555	5.496893	-96.2935	-73.2755	0.104144	2.068376
Nippon India ETF Nifty BeES etf	247	0.089694	0.710988	-3.7517	3.886003	-0.2112	12.46394
Nippon India ETF bank BeES	247	-0.18556	1.603223	-10.1342	8.6203	-0.22582	17.13189
SBI S&P BSE Sensex etf	247	0.34601	8.305662	-23.7073	24.36462	0.143225	3.585223
UTI S&P BSE SENSEX ETF	247	0.473894	2.581302	-13.5495	10.65958	-0.66369	7.572785

Sources: Eviews 9

Presents the summary statistics of the price deviation series of the selected ETFs. The measure of performance herein is used to indicate the average price deviation of the respective ETF. The mean value signifies, on average six ETF trade at premium and remaining seven at discount. The standard deviation reflects the variation in data over a period of time. After lockdown, the lowest deviation of RS-4258.94 was reported for SBI

Gold and the highest deviation of Rs 82.24002 was reported for HDFC S&P BSE Sensex ETFs.

Table 4. Testing of stationarity:

pre lockdown		during lockdown		post lockdown	
ETFs	**t statistics**	**ETFs**	**t statistics**	**ETFs**	**t statistics**
HDFC gold ETF	-5.469613	HDFC gold ETF	-1.401066	HDFC gold ETF	-6.468911
SBIGOLD ETF	-15.45994	SBIGOLD ETF	-3.421498	SBIGOLD ETF	-11.02323
HDFC S&P BSE Sensex etf	-2.552767	HDFC S&P BSE Sensex etf	-1.821542	HDFC S&P BSE Sensex etf	-15.52362
Kotak Nifty bank ETF	-14.85584	Kotak Nifty bank ETF	-23.40066	Kotak Nifty bank ETF	-14.12652
Nippon India ETF consumption BeES	-13.58653	Nippon India ETF consumption BeES	-23.40066	Nippon India ETF consumption BeES	-6.168905
Nippon India ETF infrastructure BeES	-6.084166	Nippon India ETF infrastructure BeES	-22.12712	Nippon India ETF infrastructure BeES	-13.72355
Nippon India ETF goldbees	-7.667011	Nippon India ETF goldbees	-21.99782	Nippon India ETF goldbees	-3.737135
HDFC Nifty 50 ETF	-12.23094	HDFC Nifty 50ETF	-22.0486	HDFC Nifty 50 ETF	-10.71995
Kotak nifty 50 ETF	-29.8065	Kotak nifty 50 ETF	-22.01555	Kotak nifty 50 ETF	-18.76783
Nippon India ETF niftybees	-23.29585	Nippon India ETF niftybees	-21.94746	Nippon India ETF niftybees	-11.94434
nippon india bank etf	-4.646969	nippon india bank etf	-21.95167	nippon india bank etf	-14.23855
SBI S&P BSE Sensex etf	-21.40452	SBI S&P BSE Sensex etf	-2.15E+01	SBI S&P BSE Sensex etf	-8.093676
UTI S&P BSE SENSEX ETF	-7.44E+00	UTI S&P BSE SENSEX ETF	-22.53439	UTI S&P BSE SENSEX ETF	-13.06089

Sources: Eviews 9

Result of stationarity test of price deviation series.

The study conducted an ADF test to check for the presence of unit root in the price deviation series. The results indicate that the data is stationary, as the null hypothesis is rejected at various levels of significance. This is considered favorable for applying the auto regression model. The testing stationarity was done at 1% and 5% confidence levels.

TABLE 5: Auto regression analysis
Persistence in the price deviations pre lockdown:

sr.no	ETFs	Φ_0	Φ_1	Φ_2	Φ_3	Φ_4
1	HDFC Gold ETF	0.418858	-0.41667	-0.12882	0.067708	
2	SBI Gold ETF	0.964094	-1.02109	-0.05145	0.108608	
3	HDFC s&p bse sensex etf	0.551592	-0.53536	-0.11426	0.145748	-0.13435
4	Kotak Nifty bank ETF	0.34824	-0.63469	-0.26701		
5	Nippon India ETF consumption BeES	0.321669	-0.74233	-0.16167	0.246405	
6	Nippon India ETF infrastructure BeES	0.423473	-0.79064	-0.10916	0.00934	-0.06588
7	Nippon India ETF Gold ETF	0.984049	-0.59178	-0.2065		
8	HDFC nifty 50 ETF	0.41473	-0.72955	-0.05757	0.089379	0.093127
9	Kotak nifty 50 ETF	0.04718	-0.20931	0.024217	0.128417	
10	Nippon India ETF niftybees	0.120039	-0.12453	-0.02628	0.031102	
11	Nipon India ETF bank BeES	0.525496	-0.44441			
12	SBI S&P BSE Sensex ETF	0.752748	-0.69393	-0.22033	0.227705	-0.13625
13	UTI S&P BSE Sensex ETF	0.723915	-0.80722	-0.15008	0.109061	

Sources: Author calculation

TABLE 5 (a): Auto regression analysis
Results of Persistence in the price deviations during lockdown

sr.no	ETFs	Φ_0	Φ_1	Φ_2	Φ_3	Φ_4
1	HDFC Gold ETF	0.975677	-0.94437			
2	SBI Gold ETF	5.80E-05				
3	HDFC s&p bse sensex etf	0.305371	-0.30214			
4	Kotak Nifty bank ETF	0.739391	-	0.11054		

			0.84079			
5	Nippon India ETF consumption BeES	0.686824	-0.67994			
6	Nippon India ETF infrastructure BeES	0.6018	-0.60307			
7	Nippon India ETF Gold BeES	0.593861	-0.68029	0.102104		
8	HDFC nifty 50 ETF	0.379039	-0.37466			
9	Kotak nifty 50ETF	0.228829	-0.22939			
10	Nippon India ETF niftybees	0.501846	-0.54311	0.133626	-0.03663	-0.05181
11	Nipon India ETF bank BeES	0.516929	-0.5577	0.153501	-0.10388	
12	SBI S&P BSE Sensex ETF	-0.40336	-0.02472			
13	UTI S&P BSE Sensex ETF	0.676427	-0.69886	0.022369	0.110614	-0.10251

Sources: Author calculation

TABLE 5 (b): Autoregression analysis
Results of Persistence in the price deviations post lockdown

sr.no	ETFs	Φ_0	Φ_1	Φ_2	Φ_3	Φ_4
1	HDFC Gold ETF	0.333616	-0.4497			
2	SBI Gold ETF	8.34E-05				
3	HDFC s&p bse sensex etf	0.433141	-0.40179			
4	Kotak Nifty bank ETF	0.412847	-1.02275			
5	Nippon India consumption ETF	-0.11532	-0.7763			
6	Nippon India ETF infrastructure bees	-0.13472	-0.88767			
7	Nippon India ETF Gold BeES	-0.40041	0.171094			
8	HDFC nifty 50 ETF	-0.48307	-0.53237			
9	Kotak nifty 50 ETF	-0.14966	-0.09084	0.112255	0.089878	
10	Nippon India ETF niftybees	-0.47831	-0.73262			
11	Nipon india bank ETF	-0.34114	-0.81754			
12	SBI S&P BSE Sensex ETF	0.356504	-0.4967	-0.08059		
13	UTI S&P BSE Sensex ETF	-0.49569	-0.88207			

Sources: Author calculation

Table 5, 5a, and 5b provide information on pricing persistence during different periods - pre lockdown, lockdown, and post lockdown. The minimum and maximum number of days that the price deviation persisted for each ETF during each period are reported. It

was found that during the lockdown period, a minimum of seven funds deviated for three days, while in the post lockdown period, a minimum of ten ETFs price deviated for three days. In the pre lockdown period, only two funds deviated for two days and disappeared. The maximum pricing persistence was observed during the pre lockdown period, where only one fund deviated for one day. In the lockdown period, the maximum persistence was one fund taking four days to deviate, while in the post lockdown period, only one fund took one day to deviate.

TABLE 6: Unit root test pre lockdown:

ETF	Price		NAV	
	Level	first difference	Level	first difference
HDFC gold ETF	0.8978	0.0000	0.9092	0.0000
SBIGOLD ETF	0.9023	0.0000	0.9181	0.0000
HDFC S&P BSE Sensex etf	0.4064	0.0000	0.4504	0.0000
Kotak bank ETF	0.8485	0.0000	0.8959	0.0000
Nippon india ETF consumption	0.895	0.0000	0.7728	0.0000
Nippon india infra etf	0.895	0.0000	0.7728	0.0000
nippon india goldbees	0.8273	0.0000	0.8347	0.0000
HDFC Nifty ETF	0.6918	0.0000	0.52	0.0000
Kotak nifty 50 etf	0.664	0.0000	0.5235	0.0000
nippon india niftybees etf	0.0052	0.0000	0.8563	0.0000
nippon india bank etf	0.8438	0.0000	0.8231	0.0000
SBI S&P BSE Sensex etf	0.5567	0.0000	0.4822	0.0000
UTI S&P BSE SENSEX ETF	0.3093	0.0000	0.4513	0.0000

Sources: Eviews 9

Table 6(a): Unit root test during lockdown

ETF	Price		NAV	
	Level	first difference	Level	first difference
HDFC gold ETF	0.194	0.0000	0.848	0.0000
SBIGOLD ETF	0.0113	0.0000	0.0111	0.0000
HDFC S&P BSE Sensex etf	0.0022	0.0000	0.6829	0.0000
Kotak bank ETF	0.4715	0.0000	0.5965	0.0000
Nippon india ETF consumption	0.6205	0.0000	0.548	0.0000

Nippon india infra etf	0.53	0.0000	0.6054	0.0000
nippon india goldbees	0.0065	0.0000	0.0151	0.0000
HDFC Nifty ETF	0.5424	0.0000	0.681	0.0000
Kotak nifty 50 etf	0.6167	0.0000	0.6115	0.0000
nippon india niftybees etf	0.6134	0.0000	0.3222	0.0000
nippon india bank etf	0.4445	0.0000	0.5971	0.0000
SBI S&P BSE Sensex etf	0.6669	0.0000	0.5505	0.0000
UTI S&P BSE SENSEX ETF	0.827	0.0000	0.5519	0.0000

Sources: Eviews 9

TABLE 6 (b): Unit root test post lockdown

ETF	Price		NAV	
	Level	first difference	Level	first difference
HDFC gold ETF	0.5172	0.0000	0.4281	0.0000
SBIGOLD ETF	0.2513	0.0000	0	0.0000
HDFC S&P BSE Sensex etf	0.677	0.0000	0.5496	0.0000
Kotak bank ETF	0.6723	0.0000	0.8291	0.0000
Nippon india ETF consumption	0.7387	0.0000	0.7125	0.0000
Nippon india ETF infrastructure	0.4871	0.0000	0.4533	0.0000
nippon india ETF goldbees	0.4069	0.0000	0.4535	0.0000
HDFC Nifty ETF	0.6283	0.0000	0.5332	0.0000
Kotak nifty 50 etf	0.3885	0.0000	0.5292	0.0000
nippon india ETF niftybees	0.5336	0.0000	0.5925	0.0000
nippon indiaETF bankbees	0.8552	0.0000	0.8301	0.0000
SBI S&P BSE Sensex etf	0.5939	0.0000	0.5479	0.0000
UTI S&P BSE SENSEX ETF	0.6259	0.00000	0.5479	0.00000

Sources: Eviews 9

The study aims to analyze the price discovery process of ETFs by examining the long-term relationship between the market price and NAV. The Johansen co-integration test is used for this purpose, but before applying it, the stationarity of data needs to be checked. The data should be non-stationary at the level and stationary at the same difference to use the co-integration technique. The ADF test is used to test for stationarity, and Table 5 presents the results showing that market price and NAV become stationary at the first difference, but they are non-stationary at the level during the study period. The co-

integration test can be applied to both the price and NAV of the ETF since both series have the same integration order.

Table 7: Johansen Co-Integration Test: One Vector pre lockdown

ETFs	Co-Integrating Vector	Trace Test	MaxEigen Test	Lags
Nippon india ETF niftybees	None *	11.9852	9.188844	3
	At most 1	2.796355	2.796355	
HDFC Nifty 50 ETF	None *	9.432879	7.163445	2
	At most 2	2.269433	2.269433	
Kotak nifty 50 ETF	None *	34.02527	32.17475	2
	At most 3	1.850526	1.850526	
UTI S&P BSE Sensex ETF	None *	47.28364	44.94892	3
	At most 4	2.334726	2.334726	
SBI S&P BSE Sensex ETF	None *	48.35396	44.85793	4
	At most 5	3.496027	3.496027	
HDFC S&P BSE Sensex ETF	None *	61.22296	58.27738	4
	At most 6	2.945587	2.945587	
Nippon India ETF bankbees	None *	106.3258	105.7896	2
	At most 7	0.536151	0.536151	
Kotak bank nifty ETF	None *	105.2388	103.442	4
	At most 7	1.796765	1.796765	
Nippon India ETF consumption BeES	None *	43.3872	37.16073	4
	At most 8	6.226472	6.226472	
Nippon India ETF infrastructure BeES	None *	78.39635	75.57385	2
	At most 8	2.822505	2.822505	
HDFC Gold ETF	None *	84.49359	84.48766	3
	At most 9	0.005929	0.005929	
Nippon India ETF gold Bees	None *	29.6491	29.12298	3
	At most 9	0.52612	0.52612	
SBI Gold ETF	None *	103.7137	103.6339	2
	At most 9	0.079821	0.079821	

Sources: Eviews 9

Table 7 (a): Johansen Co-Integration Test: One Vector During lockdown

ETFs	Co-Integrating Vector	Trace Test	MaxEigen Test	Lags
Nippon India ETF niftybees	None *	6.563612	5.627472	4

	At most 1	0.93614	0.93614	
HDFC Nifty 50 ETF	None *	4.762116	3.154718	2
	At most 2	1.607397	1.607397	
Kotak nifty 50 ETF	None *	6.114636	5.862929	2
	At most 3	0.251707	0.251707	
UTI S&P BSE Sensex ETF	None *	6.494334	5.895807	3
	At most 4	0.598527	0.598527	
SBI S&P BSE Sensex ETF	None *	8.83097	6.646339	4
	At most 5	2.184631	2.184631	
HDFC S&P BSE Sensex ETF	None *	21.87917	20.36575	2
	At most 6	1.513422	1.513422	
Nippon India ETF bankbees	None *	6.654045	5.677238	3
	At most 7	0.976807	0.976807	
Kotak Nifty bank ETF	None *	6.720509	5.688215	4
	At most 7	1.032295	1.032295	
Nippon India ETF consumption BeES	None *	5.787705	5.637398	3
	At most 8	0.150307	0.150307	
Nippon India ETF infrastructure bees	None *	4.366553	4.197428	2
	At most 8	0.169124	0.169124	
HDFC Gold ETF	None *	11.60574	8.780545	4
	At most 9	2.825199	2.825199	
Nippon India ETF gold Bees	None *	16.20418	8.652369	4
	At most 9	7.551815	7.551815	
SBI Gold ETF	None *	20.04169	12.19361	2
	At most 10	7.848088	7.848088	

Sources: Eviews 9

Table 7 (b): Johansen Co-Integration Test: One Vector post lockdown

ETFs	Co-Integrating Vector	Trace Test	MaxEigen Test	Lags
Nippon India ETF niftybees	None*	38.72023	35.56915	4
	At most 1	3.151084	3.151084	
HDFC Nifty 50 ETF	None*	31.79555	28.82796	4
	At most 2	2.967586	2.967586	
Kotak nifty 50 ETF	None*	10.299	7.791979	2
	At most 3	2.507019	2.507019	
UTI S&P BSE Sensex ETF	None*	41.6755	38.55354	2
	At most 4	3.121962	3.121962	

SBI S&P BSE Sensex ETF	None*	46.15212	43.61386	3
	At most 5	2.538263	2.538263	
HDFC S&P BSE Sensex ETF	None *	19.1056	17.51305	4
	At most 6	1.592549	1.592549	
Nippon India ETF bankbees	None *	32.37193	31.63574	3
	At most 7	0.736192	0.736192	
Kotak Nifty bank ETF	None *	25.64964	25.38959	2
	At most 7	0.260043	0.260043	
Nippon India ETF consumption BeES	None *	46.64861	45.49959	2
	At most 8	1.149021	1.149021	
Nippon India ETF infrastructurebees	None *	43.44038	39.90719	2
	At most 8	3.533189	3.533189	
HDFC Gold ETF	None *	32.97354	28.57403	3
	At most 9	4.399518	4.399518	
Nippon India ETF gold Bees	None *	17.16721	12.93563	2
	At most 9	4.231578	4.231578	
SBI Gold ETF	None *	3031.257	3028.977	4
	At most 10	2.280173	2.280173	

Sources: Eviews 9

The study used the Johansen co-integration test to examine the co-integrating relationship between the market price and NAV of thirteen ETFs during pre, post, and during the lockdown period. The lag selection was based on the Akaike information criteria. The results indicated that there is a long run co-integrating relationship existed between the market price and NAV during the period. The market price was used as the normalizing variable, and the NAV was treated as the independent variable. During pre-lockdown, ETFs was found to be significant in the level of cointegration. During lockdown, almost all ETFs were cointegrating, and after lockdown, ETF was found to be significant at level of cointegration. There is no long-run relationship between the market price and NAV of ETFs we reject null hypothesis.

Table 8: Vector Error correction for pre lockdown:

ETF	Variabels	Error coefficient	std error	p value	Lag	infrence
Nippon india ETF nifty bees	NAV	-0.01807	0.04691	0.00000	4	The error coefficient for the price variable is greater than that of the

	price	0.004449	-0.00619			NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
Kotak nifty 50 ETF	NAV	-0.06862	-0.05034	0.00000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.151095	-0.02838			
HDFC nifty 50 ETF	NAV	-0.01679	-0.0636	0.00000	5	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.125407	-0.05747			
HDFC S&P Sensex ETF	NAV	-0.04768	-0.05039	0.00000	3	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	-0.17939	-0.05564			
SBI S&P Sensex ETF	NAV	-0.04495	-0.0497	0.00000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	-0.38869	-0.08226			
UTI S&P Sensex ETF	NAV	-0.12881	-0.05595	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.080109	-0.07462			
Nippon india ETF bankbees	NAV	0.009425	-0.04036	0.00000	3	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.035744	-0.04185			

Kotak bank nifty ETF	NAV	0.008602	-0.07756	0.00000	2	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	-0.41984	-0.06035			
Nippon india ETF consumption	NAV	-0.03042	-0.08207	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.125505	-0.06489			
Nippon india ETF infrabees	NAV	-0.03222	-0.07823	0.00000	3	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	-0.13224	-0.0699			
Nippon india ETF Goldbees	NAV	-0.00583	-0.00733	0.00000	4	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	-0.00254	-0.04327			
HDFC gold ETF	NAV	0.092817	-0.04591	0.00000	2	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	-0.16591	-0.03903			
SBI Gold ETF	NAV	0.06058	-0.04309	0.000000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	-0.07024	-0.26095			

Sources: Eviews 9

Table 8 (a): Vector Error Corretion During Lockdown:

ETF	Variabels	Error coefficient	std error	p value	lag	infrence
Nippon india ETF nifty bees	NAV	0.043159	-0.04715	0.00000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.075307	-0.04693			
Kotak nifty 50 ETF	NAV	0.044196	-0.04691	0.00000	2	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.001457	-0.02577			
HDFC nifty 50 ETF	NAV	0.011711	-0.04792	0.00000	4	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	-0.00713	-0.03705			
HDFC S&P Sensex ETF	NAV	0.011104	-0.0476	0.00000	3	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.003968	-0.03127			
SBI S&P Sensex ETF	NAV	0.06661	-0.04677	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	-0.07755	-0.04148			
UTI S&P Sensex ETF	NAV	0.021406	-0.04693	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.102285	-0.06761			
Nippon india ETF bankbees	NAV	0.069038	-0.04807	0.00000	4	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.04752	-0.0495			
Kotak bank nifty ETF	NAV	0.079897	-0.04741	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.161022	-0.07891			
Nippon india ETF consumption	NAV	-0.0166	-0.04754	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the

	price	-0.00549	-0.07089			NAV variable is not statistically significant, indicating that NAV leads the price.
Nippon india ETF infrabees	NAV	0.029116	-0.04736	0.00000	4	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.026743	-0.05882			
Nippon india ETF Goldbees	NAV	0.094722	-0.04784	0.00000	2	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.064947	-0.05772			
HDFC gold ETF	NAV	0.063722	-0.07264	0.00000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.155863	-0.61285			
SBI Gold ETF	NAV	0.074836	-0.04777	0.000000	2	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.000543	-0.00078			

Sources: Eviews 9

Table 8 (b): Vector Error Correction post lockdown:

ETF	Variabels	Error coefficient	std error	p value	lag	infrence
Nippon india ETF nifty bees	NAV	-0.13655	-0.26063	0.00000	4	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	-0.03105	-0.22791			
Kotak nifty 50 ETF	NAV	-0.01922	-0.08801	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.171614	-0.04066			

HDFC nifty 50 ETF	NAV	-0.01504	-0.22467	0.00000	3	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.133768	-0.18885			
HDFC S&P Sensex ETF	NAV	0.00818	-0.06537	0.00000	3	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.000637	-0.05679			
SBI S&P Sensex ETF	NAV	-0.01136	-0.08466	0.00000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	-0.10794	-0.06939			
UTI S&P Sensex ETF	NAV	0.058628	-0.25384	0.00000	4	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.131976	-0.21088			
Nippon india ETF bankbees	NAV	-0.29041	-0.29722	0.00000	2	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	-0.14498	-0.27024			
Kotak bank nifty ETF	NAV	-0.01106	-0.15085	0.00000	3	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.070122	-0.14077			
Nippon india ETF consumption	NAV	0.33063	-0.21457	0.00000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV
	price	0.144332	-0.18875			

						leads the price.
Nippon india ETF infrabees	NAV	0.141635	-0.23307	0.00000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.145841	-0.20683			
Nippon india ETF Goldbees	NAV	-0.01383	-0.124	0.00000	4	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	0.289439	-0.1106			
HDFC gold ETF	NAV	0.020288	-0.07674	0.00000	4	The error coefficient of the NAV is greater than that of the price, and the coefficient of error for the price is not significant. As a result, the price is the leading the NAV.
	price	0.0171	-0.06059			
SBI Gold ETF	NAV	0.006446	-0.05278	0.000000	2	The error coefficient for the price variable is greater than that of the NAV variable. Furthermore, the error coefficient for the NAV variable is not statistically significant, indicating that NAV leads the price.
	price	-2.06E-06	-9.20E-05			

Sources: Eviews 9

CHAPTER 3

Findings and conclusion

3.1 Findings:

Based on the objectives Descriptive statistics, Auto regression, Johansens cointegration test, and Vector error correction model were conducted to measure tracking error and to study the price deviation we used descriptive statistics for pricing persistence of ETFs we run Autoregression analysis and to study long run cointegration between NAV and the market price we employ Johansens cointegration test. To determine the lead and lag indicator among NAV and the market price we use VECM (vector error correction model).

Tracking Error:

Based on objective 1: To examine the tracking error of ETFs in India during lockdown.

To examine the tracking error we have used Descriptive statistics.

Descriptive Statistics:

The results obtained from descriptive statistics where we found that the standard error average tracking error reported above one percentage even during lockdown the tracking error was reported above one percent and in post lockdown the tracking error were reported below one percent.

Pricing Efficiency:

Based on objective 2: To study the pricing efficiency of ETFs in India during lockdown.

To examine pricing efficiency we have used descriptive statistics, Augmented Dickey Fuller, Auto regression, unit root test, Johansens cointegration test, and Vector Error correction model.

Summary statistics:

The results obtained from summary statistics study found that the pricing deviation during pre lockdown six ETFs traded at a premium and the remaining Seven ETFs traded at discount and lowest price deviation was Rs 4008.39 and the highest price deviation was Rs 1125.99. During lockdown we found that for almost all ETFs traded at a discount the lowest deviation was Rs -5027.23 and the highest price deviation was Rs 632.28.

After the lockdown study reported six ETFs trade at a premium and the remaining seven ETFs traded at discount the lowest price deviation was Rs. -4258.94 and the highest price deviation was Rs 82.24002.

Unit root test to test Stationarity of pricing persistence:

The ADF test was conducted to check for the presence of a unit root in the price deviation series, and the results showed that the data is stationary as the null hypothesis was rejected at various levels of significance. This is a positive outcome for applying the auto-regression model in the present study.

Auto regression:

We found that minimum ten ETFs price deviated for three days in post lockdown, and during lockdown minimum seven funds deviated for three days. In pre lockdown minimum two funds deviated for two days to disappear. Maximum pricing persistence in pre lockdown period only one fund deviated for one day during lockdown maximum one fund took four day to deviate. And also in post lockdown only one fund took one day for price to deviate.

Unit root test to test satationarity for Johansens cointegration test:

The ADF unit root test results reveal that both the market price and NAV become stationary at the first difference, but they are non-stationary at levels during the study period. This indicates that a co-integration test can be applied to the price and NAV of the ETF, as both series are integrated at the same order.

Johansen cointegration test:

The results indicated that there is a long run co-integrating relationship existed between the market price and NAV during the period. The market price was used as the normalizing variable, and the NAV was treated as the independent variable. During pre-lockdown, ETFs was found to be significant in the level of cointegration. During lockdown, almost all ETFs were cointegrating, and after lockdown, ETF was found to be significant at level of cointegration. There is no long-run relationship between the market price and NAV of ETFs we reject null hypothesis.

Vector error correction model:

The VECM analysis reveals the dynamic interplay between the variables and sheds light on the lead-lag relationship. The findings suggest that prior to the lockdown, the NAV led the price as the error coefficient of the price was greater than that of the NAV. However, during the lockdown period, the results was opposite observed as the error coefficient of NAV was higher than the price, with the price error coefficient being insignificant. After the lockdown, the results reverted to the pre-lockdown pattern, with

the NAV leading the price as the error coefficient of the price exceeded that of the NAV. We reject null hypothesis for pre and post lockdown.

3.2 Conclusion:

This study tried to study and examines the tracking error and pricing efficiency during covid lockdown the sample period was from pre, post, and during lockdown for the study we have taken five years of closing price data and thirteen samples of ETFs based on the highest (AUM) Asset under management. In this study we have used summary statistics to represent tracking error and for pricing efficiency we used summary statistics to measure price deviation to understand the pricing persistence we run Auto regreesion analysis for pricing persistence. Johansens cointegration test was conducted to understand weather ETF price and NAV cointegrate with each other, and Vector error correction model was run to the study speed of adjustment/correction for the period of lockdown. The study concludes that the tracking error was found to be more than one percent during lockdown and pre lockdown where the ETFs tracking difference was more to its underlying indexes the tracking error was not efficient for the lockdown period making the ETFs could be more costlier and expensive being the tracking error more to its underlying it will result to more redemption to the ETFs. The study also concludes that the pricing efficiency and price discovery were more efficient during lockdown where the pricing deviation of ETFs were less during lockdown where the ETFs were traded at discount where one could enjoy Arbitrage of pricing persistence. The pricing persistence took two days to disappear during lockdown it took three days to deviate and after lockdown it took two days to deviate the price. The cointegration during lockdown was insignificant and was not cointegrated with the ETFs price and NAV. The VECM concludes that the lead lag relation between ETFs NAV and price through lockdown where error coefficient of NAV is higher than price and price error coefficient is not significant hence, the price leads the NAV. And afer lockdown the Error coefficient of price is higher than NAV and NAV's error coefficient is not significant hence, the NAV leads the price the market has corrected/adjusted the deviation.

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