AN EMPIRICAL STUDY ON MEASURES OF PERSISTENCE IN EXCHANGE TRADED FUNDS IN INDIAN STOCK MARKETS

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ABSTRACT

Exchange Traded Funds are considered as efficient, if they track the price fluctuations of their Benchmark Asset and adjust the prices accordingly. However, if these ETFs exhibit persistence, then they may not track their benchmark prices fully and this may result in arbitrage trading and thus poses a serious concern. The present article explores the measures to identify and evaluate the presence of such persistence in ETFs. For this purpose three major ETFs structured on Nifty Fifty Index were selected on the basis of their average turnover. Daily closing values of all the selected variables were taken for a reference period of two years ranging from 01-04-2016 to 31-03-2018 and the study employed ACF/PACF Test and GARCH (1,1) Model and Runs Test and it was found that the ETFs had significant autocorrelation in their lagged prices and the shocks do not die down rapidly which clearly indicated that there is significant persistence in the prices of these ETFs.

Key words : Nifty ETFs, Persistence, ACF/PACF, GARCH(1,1), Q stats, Runs Test

1 INTRODUCTION

Persistence means a course of action that continuously occur and exist firmly over a prolonged period. Persistence is an intertemporal variation it is due to enduring tendency of the price. It really takes zero time for the price to fluctuates due to unanticipated shocks and news. Persistence consists of patterns available in the movements of the stock prices.

According to the previous studies, it is believed that if the returns have been high in the recent past, then they would be high in the future also. It is normal tendency of a human in investment behavior that if an increase is expected, the buying increased, which makes market healthy by pushing up the prices beyond sustainable levels. Meanwhile when they realize that the future performance will go against their expectation, they turn sellers and this will bring back the prices to normal levels. So the price remain fluctuating. This is just one instance in stock market in the variation of the price, likewise there are several reasons where price gets influenced and make the movement in stock market. The current proposed is an empirical methodology to construct a suitable model to check the persistence of ETFs in Indian stock market. Continuing or repeating behavior in of ETFs is examined in the current study. ETFs are the Exchange-traded Funds introduced firstly in S&P 500 over two and a half years before. They are the financial vehicle acts as a basket of securities and the type of funds that includes the assets such as bonds, stocks, gold bars, etc. They attract investors with their special advantages of index strategies and Cost benefits, Fair and accurate assessment, transaction transparency and benefits of tax efficiency

1a) Evolution of ETFs

In 1989, S&P 500 for index participation of shares launched ETFs, It was listed as Mutual Fund in Stock exchange. It was ceased by CME (Chicago Mercantile Exchange) therefore it failed in its early attempts. In 1990, the Canada, Toronto index participation shares restarted trading in Toronto Stock Exchange (TSE 35) and it was an instant hit among the stock market. Hence it rose back from the dead like a phoenix. The increasing achievements of this product reinforced the trading system in US. In January 1993 Standard & Poor's Depositary Receipts(Standard & Poor's Depositary Receipts familiarly known as SPDRs or “Spiders”) (NYSE Arca: SPY) was developed and designed by Nathan Most and Steven Bloom, which was routed by Ivers Riley, this fund turn out to be the largest ETF in the world. MidCap entered SPDRs in May 1995 (NYSE Arca: MDY). In 1996, a part of ETFs family that are managed by Black rock know as ishare was initiated. Ishares are also familiar as WEBS(World equity benchmark shares). Initial iShares ETFs to debut involved a complement of international equity ETFs targeting Australia (EWA A-), Canada (EWC
B-) etc later they were set up as Mutual funds. In 1998 targeting US economy array of product, spider arrived that follows nine sectors of &P 500. These are much more upfront, splitting up the &P 500 by sectors. In 1998 an effort of reproducing the movement of the NASDAQ to the influential "cubes" (NASDAQ:QQQ) were launched. The prominence towards spreading knowledge and ideas of distribution of long-term investors Barclays Global investors were strongly determined in 2000. In 2001 the vanguard group entered the market. In 2002 the opening bonds funds were created by ishare. These were grounded with US treasury bonds and corporate and hence enormous amount of growth of bond ETFs took place. In 2004 Gold (GLD) SPDR and the first commodity ETFs (GLD A-) to contribute physical gold bullion were introduced. In 2006 in order to offer exposure to commodity futures contract the two exchange-traded notes were launched. In 2009 the debut of commission-free happened aimed at trade commission free within schwabulk.

1b) ETFs in India

NSE says "ETFs are just what their name implies: baskets of securities that are traded, like individual stocks, on an exchange. Unlike regular open-end mutual funds, ETFs can be bought and sold throughout the trading day like any stock". “The Exchange-Traded Funds Manual,” the first real attempt in India was the launch of Index Participation in 2002 named nifty BEEsS which was based on the S&P CNX Nifty Index.

As recognized in other market ETFs in India is a basket of stocks that reflects the composition of an Index, like Nifty 50. As mentioned earlier it is well known that when compared to index Mutual funds charges of ETFs will be relatively low. In India the forces of supply and demand persuade the price of an ETF share on a stock exchange. Indian ETF unit will be bought and sold on daily basis inclusive of the brokerage, which always makes investors to feel the decreased burden of transacting frequently and also persuade them to operate regularly. ETFs units in India are comprised of two components – Portfolio deposit and cash component. It is definitely a part of emerging trend toward segmentation of the mutual fund marketplace in NSE.

The total market capitalization of Indian economy owned and diversified blend of the major companies. Recently data has revealed that India’s gold collection under exchange-traded fund rose 25.7% on year to 7.049 tonnes in October when the yellow metal touched new record highs. ETF's available on NSE are diverse lot - Equity, Debt, Gold and Index ETF's are available.

The organization of the paper is done as follows: Section 2 contains a brief literature review. Methodology and empirical results are presented in Section 3 and 4 respectively. Concluding remarks are placed in Section 5.

2 LITERATURE REVIEW

Madhusoodanan (1998) applied the variance ratio tests under the null hypotheses of homoscedasticity as well as heteroscedasticity, to the Indian stock market. The tests are conducted at the aggregate level of market indices and disaggregate level of individual stocks. The results indicate that random walk hypothesis cannot be accepted in the Indian market. Both the market indices the author tested showed persistent behaviour, while most of the individual stocks also showed evidence on persistence. The variance ratios were significant under heteroscedasticity in most of the cases where it was significant under homoscedasticity assumption. This implies that heteroscedasticity does not play a major role in the Indian market. James M. Poterba, Lawrence H. Summers (2004) examined the potential influence of changing volatility in stock market prices on the level of stock market prices, they also tried to demonstrate that volatility is only weakly serially correlated, implying that shocks to volatility do not persist. These shocks can, therefore, have only a small impact on stock market prices, since changes in volatility affect expected required rates of return for relatively short intervals. These findings lead us to be skeptical of recent claims that the stock market's poor performance during the 1970's can be explained by volatility-induced increases in risk premia.

Gayathri Mahalingam, Dr. Selvam Murugesan, Dr. Gayathri Jayapa(2012) found evidences of long memory in the returns from the data collected from Indian Bombay Stock Exchange. Fractal Market Hypothesis (FMH) explores the application of chaos theory and fractals to finance, mainly the investors may not directly react to information. Instead, the investors may normally react with delay. The standard complement of statistical techniques used to identify predictable market structure is capable of identifying regular periodic cycles. The Indian stock market has a high degree of persistence. Sullivan and Xiong (2014) discuss the negative aspects of increased indexing, including a rise in security co-movements. Some papers (e.g., Ben David et al, 2015) argue that ETF arbitrage activity adds a layer of additional volatility to security prices. A subset of this literature speaks to issues of systemic risk, some related to the rise of ETF trading volumes. Madhavan A. (2014) in this article provided a unified framework to examine the issues and reviewed the research till date, demonstrating that ETFs have extended significant benefits to investors and to the functioning of markets that meaningfully outweigh any perceived or actual weaknesses. Madhavan (2016) have focused on the potential detriments to increased passive investing. Increased passive investing has been cited as a source of diminished price discovery in individual 3 securities, and hence an explanation for poor performance by active managers.

3 RESEARCH METHODOLOGY

The primary objective of this paper is to verify and measure the persistence of past information if any, in ETF's in India. For this purpose, three major NIFTY ETFs were selected based on their average daily turnover and the selected ETFs have registered a daily average turnover of 400000 shares and more. The chosen ETFs are Nifty Bees, Nifty I win and Kotak Nifty and are termed as NB, NI, and KN respectively. Further NIFTY FIFTY Index Values were considered as the underlying asset.

The daily closing prices were considered for all the variables for a period of one year ranging from 17-12-2016 to 18-12-2017 and were collected from NSE website.
Initially, the data that has been obtained for the study was subjected to their first differences to obtain the returns of the respective series by applying the following formula:

\[ \text{RETF}_t = \frac{\text{RETF}_t - \text{RETF}_{t-1}}{\text{RETF}_{t-1}} \times 100 \]  

(1)

Where \( \text{REFT}_t \) = the return on ETF’s at day \( t \)

3 a) TESTS FOR PERSISTENCE

If the information is disseminated quickly, the opportunities for arbitrage disappear in a short period of time due to the price pressure formed by rational investors. To test persistence, we employ Autocorrelation Function Test and GARCH Modeling

3ai) Autocorrelation Function Test

The autocorrelation function (ACF) test is examined to identify the degree of autocorrelation in a time series. It measures the correlation between the current and lagged observations of the time series of ETF returns, which is defined as:

\[ p_k = \frac{\sum_{t=1}^{n-k} (\text{RETF}_t - \overline{\text{RETF}})(\text{RETF}_{t+k} - \overline{\text{RETF}})}{\sum_{t=1}^{n} (\text{RETF}_t - \overline{\text{RETF}})^2} \]  

(2)

where \( k \) is the number of lags and REFT is the return of the ETF and two important elements for estimating of autocorrelation are the standard error test and the Box-Pierce Q (BPQ) test. The standard error test measures the autocorrelation coefficient for individual lags and identifies the significant one, while the Box-Pierce Q test, measures the significant autocorrelation coefficients at the group level.

The standard error \( \sigma_k \) is defined as:

\[ \sqrt{\frac{1 + 2 \sum_{t=1}^{k-1} \theta_t^2}{N}} \]  

(3)

where \( N \) is the total number of observations and \( \theta_k \) is the autocorrelation at lag \( (k) \).

Box-Pierce Q is identified as:

\[ N(N + 2) \sum_{t=1}^{k} \frac{\text{RETF}_t^2}{N-t} \]  

(4)

3a ii) GARCH MODELLING

In order to analyze the transmission of volatility and the persistence of shocks in ETFs Generalised Autoregressive Conditionally Heteroscedastic model (GARCH) is taken into consideration. GARCH model allows the conditional variance to be dependent upon previous own lags apart from the past innovation. Through GARCH model, it is possible to interpret the current fitted variance as a weighted function of long-term average value information about volatility during the previous period as well as the fitted variance from the model during the previous period.

The first step in GARCH modeling is to fit a mean equation. This should be done by fitting AR or MA models and the residuals must be checked for autocorrelation and ARCH effect.

The following AR model was used to fit an ARIMA model
Mean Equation

**AR model:** \[ Y_t = \alpha + \beta Y_{t-p} + \epsilon_t \] where \( \epsilon_t \sim N(0, \sigma^2_t) \) and \( p=1,2,3,\ldots,n \)...................................................(5)

**MA model:** \[ Y_t = \alpha_t - \epsilon_t - \theta_{t-1} \] .................................................................(6)

The next step was to fit a variance equation by taking the residuals from the fitted ARIMA model. For this purpose the model used was

**Variance Equation**

\[ h_t = \omega_0 + \beta \epsilon^2_{t-1} + \alpha_1 h_{t-1} \] ...................................................(7)

where \( \omega_0 > 0, \beta_1 \geq 0, \alpha_1 \geq 0 \). In the above equation, \( h_t \) is the conditional variance of exchange rates, which is a function of mean \( \omega_0 \).

News about volatility from the previous period is measured as the lag of the squared residuals from the mean equation \( (\epsilon_{t-1})^2 \), last period’s forecast variance \( (h_{t-1}) \) is considered as the persistence coefficient.

3 a iv) RUNS TEST

The runs test (Bradley, 1968) can be used to decide if a data set is from a random process. A run is defined as a series of increasing values or a series of decreasing values. The number of increasing, or decreasing, values is the length of the run. Fama (1965) defines runs as a sequence of price changes of the same sign. The run in a run test is the consecutive sequence of ones and twos. This test checks whether or not the number of runs is the appropriate number of runs for a randomly generated series. The larger is the positive serial dependence in price changes, the smaller is the actual number of runs than the expected number of runs. Assuming that price changes are independent, the total expected number of runs, \( E(R) \) can be obtained by:

\[ E(R) = \mu_R = \frac{2 n_1 n_2}{n_1 + n_2} + 1 \] \hspace{1cm} (8)

Where \( n_1 \) and \( n_2 \) are the runs of the price changes of each sign. The variance of \( E(R) \) is

\[ \sigma^2_R = \frac{2 n_1 n_2 (2 n_1 n_2 - 2 n_1 - n_2)}{(n_1 + n_2)(n_1 n_2 - 1)} \] \hspace{1cm} (9)

The actual runs represented by \( R \) is then subjected to \( Z \) test as follows

\[ Z = \frac{R - \mu_R}{\sigma_R} \] \hspace{1cm} (10)

The \( Z \) value is then used to verify whether the difference between the actual runs and expected runs is statistically significant or not. If the null of no difference cannot be rejected than we can conclude that the returns are independently distributed and if the null of no difference is rejected then we can conclude that the return sequence is not independent and random, hence there may be significant correlation in the past prices

4 PRESENTATION AND DISCUSSION OF RESULTS

4.1 Results of Autocorrelation Function Test

Fig. 1 to 4 plots the correlogram of the serial correlation on ETFs along with their Benchmark to test for the persistence in the current prices
The ACF and PACF plots of Index Returns reveal that the 4th to 7th lags have autocorrelation with Q values of 11.8887, 13.8276, 14.1739, and 14.1995, along with p-values of less than 0.05%, which are statistically significant and we can deduce that the current returns are correlated with past returns and, on average, the persistence of any new information will be for a minimum of 5 to 6 days.
The ACF and PACF plots of NB Returns reveal that none of the lags NB Returns are significant. In other words, successive returns are not correlated with each other.
The ACF and PACF plots of NI Returns reveal that starting from 4th lag, all successive lags have autocorrelation with Q stats reporting highly significant p-values of less than 0.05\%, indicating that the returns are highly correlated and the persistence does not die down even after two weeks. Further, the PACF also registers the similar pattern of high degree of autocorrelation.
The ACF and PACF of KN Returns register a peculiar pattern which reports no correlation at any level. This can be termed as a white noise process. However, a careful observation of the data reveals that KNETF underwent a major change of stock split in its due course and in the opinion of the author, this may have manipulated the data.
4.2 Results of GARCH Modeling

Table 1 presents the results of GARCH Modeling for ETFs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Test value</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NBR-Mean Equation ARIMA(1,1,1)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.085821</td>
<td>0.031468</td>
<td>2.727251</td>
<td>0.0064</td>
<td></td>
</tr>
<tr>
<td>AR(1)</td>
<td>-0.802727</td>
<td>0.092478</td>
<td>-8.680174</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>MA(1)</td>
<td>0.857927</td>
<td>0.082661</td>
<td>10.37883</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td><strong>Variance Equation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GARCH(1,1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.026169</td>
<td>0.010442</td>
<td>2.506145</td>
<td>0.0122</td>
<td></td>
</tr>
<tr>
<td>$\varepsilon^2_{t-1}$</td>
<td>0.084206</td>
<td>0.022245</td>
<td>3.785421</td>
<td>0.0002</td>
<td></td>
</tr>
<tr>
<td>$h_{t-1}$</td>
<td>0.870189</td>
<td>0.033309</td>
<td>26.12448</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td><strong>NIR-Mean Equation ARIMA(2,1,2)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.092364</td>
<td>0.029938</td>
<td>3.085189</td>
<td>0.0020</td>
<td></td>
</tr>
<tr>
<td>AR(3)</td>
<td>0.028997</td>
<td>0.024955</td>
<td>1.161952</td>
<td>0.2453</td>
<td></td>
</tr>
<tr>
<td>AR(8)</td>
<td>-0.867177</td>
<td>0.024081</td>
<td>-36.01056</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>MA(3)</td>
<td>-0.094751</td>
<td>0.019776</td>
<td>-4.791249</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>MA(8)</td>
<td>0.905663</td>
<td>0.017911</td>
<td>50.56381</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td><strong>Variance Equation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GARCH(1,1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.021849</td>
<td>0.009984</td>
<td>2.188439</td>
<td>0.0286</td>
<td></td>
</tr>
<tr>
<td>$\varepsilon^2_{t-1}$</td>
<td>0.123063</td>
<td>0.029626</td>
<td>4.153926</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>$h_{t-1}$</td>
<td>0.841705</td>
<td>0.037508</td>
<td>22.44044</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td><strong>IR Mean Equation ARIMA(1,1,0)</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
GARCH (1,1) Model was applied on the returns of all the variables in order to verify the persistence of shocks in the conditional variance of these variables. When GARCH is applied on the returns as per the procedure mentioned in equations (7) and (8) the coefficients $\varepsilon^2_{t-1}$ and $h_{t-1}$ convey the extent to which the previous shocks impact the current prices. The coefficient $\varepsilon^2_{t-1}$ measures the previous day’s shock and the coefficient $h_{t-1}$ reports the accumulated and unabsorbed variance of the previous periods of shocks. The sum of these two coefficients conveys the extent to which persistence is present in the past returns of the chosen variables. If the sum is close to unity than there is high level of persistence and would result in delayed reversion to the mean returns. If the returns of a variable take time for mean reversion than it may lead to arbitrage opportunities and may reduce the efficiency of pricing of these ETF’s.

The NBR and NIR persistence were reported at 0.954 and 0.964 respectively against the persistence of IR at 0.987 which is a clear indication of significant autocorrelation in the past returns of these ETF’s.

### 4.3 Result of Runs Test

<table>
<thead>
<tr>
<th>Variable</th>
<th>Actual Runs(R)</th>
<th>Expected Runs($\mu_r$)</th>
<th>Z-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NBR</td>
<td>254</td>
<td>248.49</td>
<td>0.498</td>
<td>0.690</td>
</tr>
<tr>
<td>NIR</td>
<td>243</td>
<td>248.3778</td>
<td>-0.48663</td>
<td>0.313262</td>
</tr>
<tr>
<td>KNR</td>
<td>214</td>
<td>233.2182</td>
<td>-1.85382</td>
<td>0.031883</td>
</tr>
<tr>
<td>IR</td>
<td>250</td>
<td>248.499</td>
<td>0.135757</td>
<td>0.553993</td>
</tr>
</tbody>
</table>

The Runs Test was employed to verify whether the prices of the chosen series are independent of their past prices and random and the results reveal that NBR series have more actual runs than the expected runs. However, the Z test reveals that this difference is
not significant as the p-value 0.690% is more than the alpha value of 0.05%. NIR actual runs are lesser than expected runs but this difference is not significant as the p-value of 0.31% is more than the alpha value of 0.05%.

KNR has actual runs lesser than the expected runs and the difference in runs is statistically significant as the p-value of 0.03 is lesser than the alpha value of 0.05%. therefore we can deduce that KNR prices are correlated with their past prices and are not independent.

5 CONCLUSIONS

The present article explores the measures to identify and evaluate the presence of such persistence in ETFs and for this purpose, three econometric tools were applied on the chosen ETFs and the results reveal that the NIFTY ETFs are not efficient in their prices as their current prices are correlated with their past prices. When the prices of the securities are not random than it gives chances of arbitrage opportunities which will have a negative impact on the marketability and credibility of the funds. Further, as these funds are derivatives, they must be quick in tracking and adjusting to the price fluctuations of the benchmark index. But these ETFs are not exhibiting such practice as it is evident from the consistence autocorrelation of the past prices. Further, they also exhibit noticeable persistence in the past prices which is another signal of inefficiency of prices. Indian ETFs must adopt the tracking and management styles of US ETFs which are robust in following their benchmark in this regard.

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