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Indian Energy-Oil-Gas Stock Behaviour During Nifty 50 Index Reconstitution: Interpreting Volatility Dynamics Through Var Analysis

Shakya Singha Dey
Assistant Professor, Department of Commerce, Nabagram Hiralal Paul College
(Affiliated to University of Calcutta)

Abstract

The paper examines how inclusion and exclusion of the NIFTY 50 index (i.e., index reconstitution) can affect the short-term return behaviour (i.e., volatility dynamics) of the sample companies selected within Indian Energy, Oil and Gas sector namely Hindustan Petroleum Corporation Ltd., Indian Oil Corporation Ltd., Suzlon Energy Ltd. and Coal India Ltd. The Vector Autoregression (VAR) analysis using the daily stock returns was run separately on the dataset preceding the event data and the post event data, to study the change in lagged relationship of the returns and the explanatory ability. This shows that the R square values tend to be low in all the companies meaning that there is not much predictability of lagged returns in the short term. Hindustan Petroleum, Indian Oil, and Suzlon Energy demonstrated minimal changes over time, whereas, Coal India was seen to significantly improvise r-square and a second-lag positive post- event result, which was also close to significant.

Sector-wide testing indicated that index changes did not always lead to higher predictability in returns hence, weak-form efficiency within this context. The implication of the findings is that index events cannot be an accurate indicator of short term trading in this industry. The studies have implications to the investors, policymakers and researchers as there must be consideration of more macro economies and sector specific factors as well as alteration of the index. Suggestions are provided as to utilization of multi-factor models, and observation of market manipulation during index events and protruding research with longer or higher frequency event periods to achieve delayed or intraday impact.

Keywords: nifty 50, index inclusion, index exclusion, vector autoregression, energy sector, stock returns

1. Introduction

The NIFTY 50 is a major index of the Indian equity market tracking performance by the major companies in terms of market capitalization and liquidity. Its reconstitution, which is periodic and can trigger additions or removals, can influence behaviour of investors, trading volumes, and results in moving up or down the index funds during portfolio rebalancing. The energy, oil & gas business is of a significant national importance to the Indian economy as it has hugely successful corporations such as Hindustan Petroleum, Indian Oil, Suzlon Energy, and Coal India. Analysis of lagged returns relationships and transformation in market

dynamics prior and following such index events is achievable under the use of Vector Autoregression (VAR) model.

Problem Statement

Index reconstitution effects have received a lot of research in other world markets but little has been conducted on sector-based research in the context of India. There is little literature on the impact of such changes on short-term returns dynamics applying the VAR framework, especially in the Energy, Oil & Gas industry (Srivastav and Kannadhasan, 2025)[1]. This general analysis without specific focus leaves a vacuum in the interpretation of the role of such events on market behaviour of sectors.

Objectives

- To examine the influence of the NIFTY 50 index reconstitution on an array of pre-selected Energy, Oil & Gas companies by means of the VAR model.
- To compare pre/ post inclusion/exclusion period lagged return relations.
- To determine trends or changes in both explanatory strength (r-square) and lag coefficients over these two periods.
- To give guidance to investors, analysts and policymakers in terms of sector-relevant market responses.

Research Questions

1. What are the values of lagged returns (RETURN (-1) and RETURN (-2)) after and before Index reconstitution of the chosen firms?
2. Is there a big difference in the explanatory power of the VAR model between the pre and the post event periods?
3. Do the Energy, Oil & Gas companies studied show consistent trends in terms of dynamics of returns?

2. Literature Review

Stock markets are sensitive to the occurrence of several events and index reconstitution plays a critical role in determining price and the returns. The actions of the commitment or not by major indexes of companies is important to investors, policymakers, and academics. Statistical and econometric modelling has been done on the event-driven effects in previous studies. Nevertheless, sector studies, especially in the Energy, Oil & Gas industry, have been less. The most important areas that are reviewed and covered in this paper include: event study methodology, VAR models findings, the inclusion/exclusion of indices, sector-specific performances, and gaps in current research.

According to Harris and Gurel (1986)[2], The event study approach is used to determine how markets react to certain events and it involves measurement of price and volume of quantity near the date of the event. Their analysis of the changes on the S&P 500 index gave a good indication of the immediate price effects of index additions due to the movement of demand

by index funds and institutional investors (Harris and Gurel, 1986)[2]. The methodological procedure tends to establish event windows, estimate the expected returns, and compute abnormal returns. It has been an extensively popular method to test how corporate announcement releases and changes of policies and index constitutions have an effect on stock performance and as such formed a great source of empirical research in financial studies.

According to Pani (2025)[3], Statistical Variable Vector Autoregression (VAR) Vector Autoregression (VAR) model depicts the dynamism between various time series, bearing in mind that the present value of a subject or information is affected by the past values on the time series. VAR models in financial markets VAR models are common to investigate the interdependencies between stock returns, volatility and macroeconomic factors (Pani, 2025)[3]. They enable researchers to investigate the way in which shocks in one variable are transmitted across the system as time passes by. The fact that it used lagged values assists in the comprehension of interactions in the short-term and medium-term and thus this makes it applicable in the study of pre and post events in index reconstitution studies where effects of lag can often play a role in the market rebalancing.

According to Lamoureux and Wansley (1987)[4], any movement on major stock indices like the S&P 500 can be the cause of a major market reaction. In their study they concluded that additions to the index can produce an upward pressure on the stock price as more investors demand the stock and deletions could cause a draw down (Lamoureux and Wansley, 1987)[4]. The effects can be either short lived or can be permanent based on market and behavior of investors. These kinds of findings have also led to studies in other markets such as emerging economies to study the impacts of changes in index on pricing, liquidity and investor sentiment.

According to Suresh (2024)[5], the geopolitical events have influenced the Energy, Oil & Gas financial sectors of the BRICS financial market like the Russia-Ukraine war. It was pointed out in the study that price volatility in energy shares becomes high when there is global uncertainty and these prices are being influenced by variation in supply chain, commodity prices and risk perception of an investor (Suresh, 2024)[5]. Such industry dynamics indicate that the nature of the industry could be a factor that can affect the reaction of stocks to index inclusion or exclusion events.

Literature Gap

Although the impacts of index reconstitution and the use of VAR model in the financial literature have been examined in the literature, sector-based applications in India are limited. The Energy, Oil & Gas industry has received little attention especially with regards to the analysis of pre and post event differences in the dynamics of returns in a VAR set-up (Wong and Ge, 2025)[6].

3. Methodology

In this research, a quantitative research design has been used where the pattern of stock returns prior and subsequent to reconstitution of NIFTY 50 index is based on event study.

Vector Autoregression (VAR) model is used to measure or record pending associations between stock returns during pre- and post-event phases (Ogieriakhi, 2025)[7]. Delegating the analysis because of the two phases will allow establishing the modification of the relations of returns dependence, explanatory power, and the behavior of specialty in using chosen Energy, Oil & Gas companies.

The stock returns involved in the calculation were extracted and it was done using the National Stock Exchange (NSE) database on a daily basis of Hindustan Petroleum Corporation Ltd., Indian Oil Corporation Ltd., Suzlon Energy Ltd. and Coal India Ltd. The data both includes pre and post-events of index inclusion or exclusion (Chakrabarti, 2021)[8]. Corporate actions like stock splits and dividends had to be adjusted which made all the data consistent and accurate in estimation.

Energy, Oil & Gas was chosen as it contributes greatly to the Indian economy besides being sensitive to macro-economic, as well as geopolitical factors. The companies within this industry tend to be volatile thus only event-based analysis is appropriate. We chose this selection (NSE classification and availability of total history) because of the existence of prior research.

The concentration on Hindustan Petroleum, Indian Oil, Suzlon Energy and Coal India indicates a combination of oil refinement, electrical energy production and extraction of natural resources. The companies within this group of companies represent a wide range in terms of operational sectors in the Energy, Oil & Gas sector and therefore the potential to review whether index reconstitution effects may vary depending on sub industry within the same industry can be explored.

There were two distinct windows of events identified namely the pre-period which entailed trading days prior to addition or deletion to the NIFTY 50 index and the post-period which entailed trading days following the event (Basu, 2022)[9]. This split allows one to compare the dynamics of returns and lag relations with any possible change of market behavior caused by the index reconstitution.

The interactions VAR model implies are between current returns on the stock and lagged ones. In every firm, there were two lags RETURN (-1) and RETURN (-2) and constant entry. The parameters of the model were estimated in both pre- and post and these could give an indication of whether the magnitude and direction of lagged returns effects had changed (Ritho, Simiyu and Omagwa, 2023)[10].

EViews 10 was used in carrying out separate VAR estimations of pre- and post-periods. The method used to choose the model was the Akaike and Schwarz Information Criteria, which ensured the best lag structure and statistical soundness pertaining to parameter estimation.

4. Results

4.1 Hindustan Petroleum Corporation Ltd.

4.1.1 Pre-Period VAR Results

Vector Autoregression Estimates
Date: 05/14/24 Time: 13:33
Sample (adjusted): 6/27/2017 8/24/2017
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	-0.081784 (0.15984) [-0.51165]
RETURN(-2)	-0.071446 (0.15992) [-0.44677]
C	-0.005611 (0.01300) [-0.43150]
R-squared	0.010869
Adj. R-squared	-0.039856
Sum sq. resids	0.273550
S.E. equation	0.083750
F-statistic	0.214273
Log likelihood	46.11734
Akaike AIC	-2.053206
Schwarz SC	-1.929087
Mean dependent	-0.004671
S.D. dependent	0.082130

Figure 1: VAR Model
(Source: Self-Created in Eviews 10)

The pre-period model of Hindustan Petroleum has extremely low explanatory power as the r-square is 0.010869. Both lagged returns are both negative RETURN(-1) = -0.081784, RETURN(-2) = -0.071446) and insignificant. The R-squared value is negative (-0.039856) and the F-stat (0.412273) indicates that the low predictor of the model preceding the index changes.

4.1.2 Post-Period VAR Results

Vector Autoregression Estimates
Date: 05/14/24 Time: 13:24
Sample (adjusted): 10/06/2017 12/05/2017
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	-0.020662 (0.15984) [-0.12927]
RETURN(-2)	0.023988 (0.14947) [0.16049]
C	-0.001436 (0.00228) [-0.62900]
R-squared	0.001164
Adj. R-squared	-0.050058
Sum sq. resids	0.008313
S.E. equation	0.014600
F-statistic	0.022725
Log likelihood	119.4841
Akaike AIC	-5.546862
Schwarz SC	-5.422742
Mean dependent	-0.001417
S.D. dependent	0.014248

Figure 2: VAR Model
(Source: Self-Created in Eviews 10)
Post-period, the explanatory abilities of the model are also very poor (r-square = 0.001164 Adj. r-square = -0.050058). RETURN (-1) is just slightly negative (-0.020662) whereas RETURN (-2) is slightly positive (0.023988), but both are not significant (Akachukwu, 2021)[11]. The F-statistic (0.022725) is close to zero which means that predictability has not dropped or gained with inclusion or exclusion of the index.

4.1.3 Comparison of Pre and Post Periods

Comparatively, the two time periods show no significant gain in the explanatory value with r-square decreasing to ~0.1% against ~1%. The signs of coefficients were altered in RETURN (-2) and were insignificant. The findings are indicative of their having been no significant impact on short-term returns dynamics of Hindustan Petroleum due to change in indexes.

4.2 Indian Oil Corporation Ltd.
4.2.1 Pre-Period VAR Results

Vector Autoregression Estimates
Date: 05/14/24 Time: 13:49
Sample (adjusted): 12/19/2016 2/15/2017
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	0.132719 (0.15909) [0.83425]
RETURN(-2)	-0.032944 (0.15908) [-0.20709]
C	0.004804 (0.00274) [1.75059]
R-squared	0.017766
Adj. R-squared	-0.032605
Sum sq. resids	0.010383
S.E. equation	0.016317
F-statistic	0.352695
Log likelihood	114.8148
Akaike AIC	-5.324514
Schwarz SC	-5.200395
Mean dependent	0.005324
S.D. dependent	0.016057

Figure 3: VAR Model
(Source: Self-Created in Eviews 10)
The r-square and adjusted r-square of the pre-period model of the Indian Oil are 0.017766 and -0.023065 respectively. RETURN(-1) is a positive number (0.132719) and RETURN(-2) is a negative number (-0.032944), and all are not statistically significant (Sam, 2024)12. Before index events, there is a low F-statistic (0.345265), which means that there is poor model fit.

4.2.2 Post-Period VAR Results

Vector Autoregression Estimates
Date: 05/14/24 Time: 13:46
Sample (adjusted): 4/07/2017 6/07/2017
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	0.129957 (0.15861) [0.81937]
RETURN(-2)	-0.131441 (0.15940) [-0.82458]
C	0.002289 (0.00241) [0.94989]
R-squared	0.030124
Adj. R-squared	-0.019613
Sum sq. resids	0.009121
S.E. equation	0.015293
F-statistic	0.605660
Log likelihood	117.5352
Akaike AIC	-5.454059
Schwarz SC	-5.329940
Mean dependent	0.002318
S.D. dependent	0.015145

Figure 4: VAR Model
(Source: Self-Created in Eviews 10)

The explanatory power is higher in the post-period where it stands at r-square = 0.030124 and the adjusted r-square is negative (-0.010913). The value of RETURN(-1) is positive (0.129957) and that of RETURN (-2) is negative (-0.131441). Both coefficients are not significant and F-statistic (0.605660) continues to indicate poor performance of the model.

4.2.3 Comparison of Pre and Post Periods

In the post-period outcome, although there is a slight increase in the R (2.77-3.01 %), there are no significant changes in the coefficients. RETURN(-1) also has the same sign pattern, however the opposite happens with RETURN(-2). In total, the predictive relationship is weak and its changes of the index make a little influence.

4.3 Suzlon Energy Ltd.

4.3.1 Pre-Period VAR Results

Vector Autoregression Estimates

Vector Autoregression Estimates
Date: 09/19/24 Time: 12:42
Sample (adjusted): 12/10/2010 2/09/2011
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	-0.208250 (0.16479) [-1.26371]
RETURN(-2)	-0.152147 (0.16487) [-0.92286]
C	-0.000832 (0.00535) [-0.15551]
R-squared	0.050672
Adj. R-squared	0.001989
Sum sq. resids	0.046839
S.E. equation	0.034656
F-statistic	1.040847
Log likelihood	83.17737
Akaike AIC	-3.817970
Schwarz SC	-3.693851
Mean dependent	-0.000769
S.D. dependent	0.034690

Figure 5: VAR Model
(Source: Self-Created in Eviews 10)

In the pre-period, the model of Suzlon Energy depicts r-square = 0.050672 which is the highest result in pre-period so far. Both negative lags on returns are not significant (-0.208250 RE This F-statistic (1.040847) indicates that it fits better ever so slightly compared to Hindustan Petroleum and Indian oil pre period models (Elisha, 2025)[13].

4.3.2 Post-Period VAR Results

Vector Autoregression Estimates

Vector Autoregression Estimates
Date: 09/19/24 Time: 12:40
Sample (adjusted): 4 46
Included observations: 43 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	-0.040106 (0.15634) [-0.25652]
RETURN(-2)	0.174687 (0.16143) [1.08215]
C	0.004318 (0.00490) [0.88041]
R-squared	0.030294
Adj. R-squared	-0.018192
Sum sq. resids	0.039550
S.E. equation	0.031445
F-statistic	0.624800
Log likelihood	89.30032
Akaike AIC	-4.013968
Schwarz SC	-3.891094
Mean dependent	0.004787
S.D. dependent	0.031162

Figure 6: VAR Model
(Source: Self-Created in Eviews 10)

Suzlon post-period result indicates less good results (R2 = 0.032094) where the RETURN -1 is negative (-0.040106), whereas the RETURN -2 is positive (0.174687) yet remains insignificant nevertheless. The F-statistic (0.624800) is less compared to the pre-period, which includes the event indicating that the model fit is low following the event.

4.3.3 Comparison of Pre and Post Periods

r-square falls back to 3.21 percent, after the event, and RETURN (-2) flips to positive value. The decline in fit and lack of significance points out that the index change did not enhance the short-term predictability of returns in Suzlon (Murty, 2024)[14].

4.4 Coal India Ltd.

4.4.1 Pre-Period VAR Results

Vector Autoregression Estimates

Vector Autoregression Estimates
Date: 09/19/24 Time: 13:03
Sample (adjusted): 4 46
Included observations: 43 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	-0.018393
	(0.15911)
	[-0.11560]
RETURN(-2)	-0.187646
	(0.15901)
	[-1.18008]
C	-0.000498
	(0.00339)
	[-0.14708]
R-squared	0.033749
Adj. R-squared	-0.014563
Sum sq. resids	0.019611
S.E. equation	0.022142
F-statistic	0.698562
Log likelihood	104.3827
Akaike AIC	-4.715474
Schwarz SC	-4.592599
Mean dependent	-0.000741
S.D. dependent	0.021982

Figure 7: VAR Model

(Source: Self-Created in Eviews 10)

The pre-period model of Coal India has a value of r-square which is 0.033749, and the adjusted value of r-square is -0.014563. RETURN(-1) is not quite negative (-0.018393) and RETURN (-2) is more negative (-0.187646), again neither statistically significantly negative. The F-statistic (0.698562) reveals low results in general performance of the model prior to index changes.

4.4.2 Post-Period VAR Results

Vector Autoregression Estimates

Vector Autoregression Estimates
Date: 09/19/24 Time: 12:54
Sample (adjusted): 10/14/2011 12/16/2011
Included observations: 42 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RETURN
RETURN(-1)	-0.031603
	(0.15889)
	[-0.19890]
RETURN(-2)	0.312775
	(0.16603)
	[1.88381]
C	-0.001227
	(0.00300)
	[-0.40905]
R-squared	0.083427
Adj. R-squared	0.036424
Sum sq. resids	0.014199
S.E. equation	0.019081
F-statistic	1.774910
Log likelihood	108.2416
Akaike AIC	-5.011506
Schwarz SC	-4.887387
Mean dependent	-0.002170
S.D. dependent	0.019438

Figure 8: VAR Model

(Source: Self-Created in Eviews 10)

During the post-period, the r-square of the model increases to 0.083427 and the coefficient of RETURN(-2) is positive (0.312775) and marginally significant at 10 or alternative significance level (t = 1.88381). RETURN(-1) continues to be a little bit negative (-0.031603) (Vaze and Gilmour, 2024)[15]. Adjusted r-square value rises to 0.036424, the best among all the results of period after the model and there is a hint of an improvement in model fitting based on F-statistic of (1.774910).

4.4.3 Comparison of Pre and Post Periods

The most visible improvement is that of Coal India whose r-square rose to 8.34 percent against 3.37 percent and RETURN(-2) is swinging to positive, although this improvement was only of borderline significance. This reflects a small level of improvement in the short-term returns predictability following the index changes contrary to the other investigated companies.

5. Comparative Discussion

The VAR results in the four companies indicate that there is an overall low percentage of explanatory power during pre and post periods and the value of r-square is predominantly less than 5 percent. In the case of Hindustan Petroleum, the disparities between the pre- and post-event models are negligible, whereby no distinguished coefficients are available. Suzlon Energy has a small decline in explanatory power on post event setting, whereas Coal India is the sole company where R and a value approaching statistical significance and positive RETURN (-2) post event shows a noteworthy rise. The lagged returns in the majority of the cases are fluctuating in terms of sign during different periods, but not with respect to strong statistical evidence.

On a net basis, the Energy, Oil and Gas group has poor short-term forecastability of returns whether or not the group is included in the index. The overall low values of R2 show that there is a weak impact of previous returns in the future returns which confirms low-level of market efficiency (weak-form). Although Coal India portrays some post-event change, the aggregate sector fails to exhibit the trend of consistency in predictability of the index changes. Such results indicate that players in the market can be able to react to the index news within a short time to avoid extended price impacts.

A number of reasons can be attributed to these findings. To begin with, index changes may not have any short-term price distortions since index changes on the India stock market are highly liquid and the dissemination of information on the stock market is very fast. Second, macroeconomic factors such as oil price, exchange rate or changes in policy measures in the energy sector can severely affect stock price movements in this sector that may dominate index effects. Third, it could be an unequally reacting process across firms because of different investor base, trading volume and institutional ownership, which could also take Coal India to a unique improvement.

6. Recommendations

In terms of VAR analysis and observations of the sector, it is possible to give several suggestions to investors and policymakers and future researchers.

To the investor, trading based on index inclusion and exclusion in the Energy, Oil & Gas sector would not facilitate the consistent gains of short sale strategies since the predictability of returns associated with observed returns is minimal. Rather, solutions should be adopted by observing the general market trends in commodity price, energy needs, macroeconomic trends, etc as part of the investment decision.

To policy makers and regulators, transparency in the process of reviewing and revising the index as well as the issue of prompt publication of changes may enable them to sustain efficiency in the market (Nkrumah-Boadu, 2022)[16]. It is also good to monitor the unusual trading activities around index events to avoid the possibility of some market manipulation.

Future researchers can broaden the time frame of events, or use more detailed and frequent intraday data which can be used to capture less definitive effects in the short term. Note that by including additional types of econometric models, like GARCH or machine learning methods, one might be able to reveal more details about volatility patterns and changes in the investor response (Wahid and Mumtaz, 2025)[17]. Second, the possible control of other related industries, such as utilities, or infrastructure, would assist in deciding whether index changes affect the industries variously.

7. Conclusion and Implications

The VAR comparison between four large companies of Energy, Oil and Gas before and after inclusion/exclusion in Nifty 50 index show little predictability of returns in the short term. r-square values are weak which means that there is little exposure of lagged returns in present returns. Coal India reveals a little increase post-event and other companies do not have much change.

The findings are that index event only trading strategies in this industry might not earn persistently excess returns. Broader macroeconomic and sector indicators need to be incorporated into any investing behavior by investors and analysts which include global tendencies of oil prices to a more precise future representation.

The regulators should ensure transparency in the index review practice to maintain market efficiency. Such monitoring of activity in the abnormal market any time around the changes of the indexes would help to prevent price manipulation and ensure investors of security (Woode, 2024)[18].

The detection of delayed effects could be constrained by short event windows and low-frequency data. The future research could focus on reflecting the market reaction dynamics of the index in terms of intraday data, other models and cross-sector comparisons.

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