Do government policies impact the stock market returns? Empirical evidence from the Indian solar energy sector

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Abstract

This study aims to examine the impact of ambitious projects of "Pradhanmantri Suryodaya Yojana (PSY)" on ten stocks of the energy sector listed in the NSE. We examine the hypothesis using the standard event study methodology, for which we extract the data from the official website of the National Stock Exchange (NSE). We found that the announcement of the project did not significantly affect the stock price during the event window, except third trading day after the event, whereas there was a significant effect on stock prices in the post-event window. This is the first study, to the best of our knowledge, that examines the impact of the news announcement of "PSY". It will be helpful for the researchers working in the area of event study, policy makers, investors, and corporate firms as well, because this article bridges the gap in policy decisions on energy sectors and stock reactions. This study includes the stocks listed in the NSE only, but the inclusion of more stocks can alter the results.

Keywords: *Event Study, Energy sector stocks, "Pradhanmantri Suryodaya Yojana", Solar energy.*
JEL Classification: *G14; G18; G5*

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1. Introduction

In the coming decade, the Indian energy sector is expected to experience a transition from fossil fuel-based energy sources to renewable sources like solar and wind power. Realizing the growing potential of solar energy in Indian, the "Government of India" launched one of its ambitious projects of "Pradhanmantri Suryodaya Yojana", also known as "PM Surya Ghar: Muft Bijli Yojana" on 22 January 2024, immediately after the consecration of Suryavanshi Ram temple in Ayodhya. Keeping in line with the government's commitment to sustainable energy solutions, the initiative involves the installation of solar panels on the rooftops of 1 crore households across India. As per the policy, individuals can avail of the government subsidy of up to 40% and the concessional bank loans for the installation of solar panels on the household rooftops. In order to combat the huge energy demand in the coming years, the aim of such a policy initiative is to supply solar power at the household level, thereby reducing the

electricity bill of crores of households. By potentially saving money for households, the scheme will reduce the individual household's reliance on conventional electricity. The scheme is expected to save up to Rs. 15,000 – Rs. 18,000 cores annually for poor and middle-class people. In addition, it also gives them an opportunity to sell the surplus power to electricity distribution companies.

The major difference from the earlier solar promotion policies is that it is the Centre and not the state power distributing companies that are promoting solarization. Most of the state power distributing companies are loss-making and thus have a very minuscule incentive in moving high electricity consumption customers to sustainable energy solutions, i.e., installation of rooftop solar panels. As per the reports published in one of the leading newspapers, "The Hindu"[1] Only 12 gigawatts (GW) out of the intended 40 GW have been installed till now. The report also highlighted a low contribution of households (accounting for only 2.7GW) to the rooftop solar panel installation. Thus, at one end, the proposed policy initiative will reduce the dependence of rural households on conventional electricity consumption, and at the other end, it will also galvanize a domestic industry of solar panels in India.

Energy security concerns relating to power and fuel are majorly driven by factors such as the availability of fossil fuel-based energy resources, geopolitical uncertainty, price volatility, and import dependency. Such security concerns increase the desire towards renewable energy sources and thereby also enhance energy security by increasing control over domestic resources (Igeland et al., 2024). The news about the government policy initiatives affects the investor's behavior, which is reflected in the stock market indices. The present study tries to investigate the impact of government policy on the security concerns using an event study methodology in the Indian solar energy sector. The study found that there was no significant effect of policy announcement during the event window, except t+3, but 9 significant positive and 9 significant negative effects were found during the post-event window of 30 days, ranging from t+11 days to t+40 days.

The rest of the paper is as follows. Section 2 presents the literature review, Section 3 discusses the data and methods, Section 4 presents the findings, and Section 5 concludes the study.

2. Literature Review

In order to study the past literature in relation to how government policies impact the stock market returns, the entire review is being divided into three parts, viz., the studies which pioneered the 'event study methodology', followed by the study which tested the suitability of such event methodology. The third section sheds light on the studies relating to the solar energy sector.

2.1. Literature Pioneering the event study

In the first stage of review of literature, the studies pioneering the 'event study methodology'. The two landmark papers (Ball & Brown, 1968; Fama et al., 1969) introduced the technique of typical event studies in capital market research. However, despite being the pioneering research in the area of capital markets, the studies of Ball-Brown and Fama-Fisher-Jensen-Roll were not the first ones that reported event studies in the broad area of accounting and financial economics. (MacKinlay, 1997) found early evidence using an event study that examined the stock price reaction to stock splits. The report also referred to several other published papers reporting the event studies in the early 1960s (Ashley, 1962; Myers & Bakay, 1948).

[1] https://www.thehindu.com/opinion/editorial/a-sunshine-initiative-the-hindu-editorial-on-the-governments-rooftop-solar-panel-plan/article67810556.ece

The use of the 'market model' pattern after the recent development of the same and the use of data from the newly established 'Center for Research in Security Prices' (CRSP) at the University of Chicago were the major factors contributing to the success of the Ball-Brown and Fama-Fisher-Jensen-Roll studies. With the passage of time, event studies also became a key empirical tool in the studies devoted to capital structure issues after the emergence of the classic papers (M. H. Miller & Modigliani, 1961; M. Miller & Modigliani, 1963; Modigliani & Miller, 1958). It is a very difficult task to determine the number of papers that have adopted 'event study methodology' in the past. (Kothari & Warner, 2007) reported a publication of more than 500 papers based upon the 'event study methodology' in a time span of 1974-2000. With the passage of time, the studies based upon event studies have now not only been confined to the accounting and finance domain. There are several papers that use the event study in different areas (for example, Bhagat, 2002; Chatterjee et al., 2002; Cichello & Lamdin, 2006; C. Ghosh et al., 1995; Lamdin, 2001; McKenzie & Thomsen, 2001; Meznar et al., 1998; Nicolau, 2002; Rose, 2003).

2.2. Literature on Event Study Methodology

In the second stage of review of literature, we focus upon the studies testing the suitability event study methodology. A short-term 'event study methodology' and found parametric tests to be more suitable in the event studies in comparison to non-parametric tests only, where the return data is being extracted from the "New York Stock Exchange" (Corrado, 2011). However, it may yield inaccurate inferences where non-normality in data is severe. Thus, a non-parametric test was recommended in a condition where robustness against non-normally distributed data is desirable. In addition, he also found the relevance of event-induced variance in the event studies. Prior to the (Corrado, 2011), a plethora of research is being done by prominent researchers such as (Boehmer, 1991; Brown & Warner, 1980, 1985; Campbell & Wesley, 1993; Corrado, 1989; Corrado & Zivney, 1992; Cowan, 1992; Dimson, 1979; Dutta, 2014; Kolari & Pynnönen, 2010; Kolari & Pynnonen, 2011; Luoma, 2011; Park, 2004; Thomas Dyckman, 1984) to decide whether it's a parametric or a non-parametric test that dominates in the event studies. Prior studies (Boehmer, 1991; Dyckman et al., 1984) advocate stronger evidence for the parametric test, while findings of Corrado (1989), dictate stronger evidence for non-parametric tests.

2.3. Literature on Solar Energy Sector

In the third stage of review of literature, we focus on the studies examining the impact of macro-economic events on stock prices. Various studies have been conducted in this connection to examine the impact of macro-economic events like government regulation, government policy, inflation, pandemic, fiscal policy, etc., on the security prices. Some of them are(Belgacem et al., 2015; Ghanem & Rosvall, 2014; Joo et al., 2009; Kumari, 2021; Nikkinen et al., 2008; Pandey & Jaiswal, 2017; Pandey & Kumari, 2021b; Seďa et al., 2018; Sorokina et al., 2021) and many more.

An additional kind of uncertainty after scrutinizing the impact of oil uncertainty (Dutta, 2017). The financial markets and policy cause uncertainty and volatility in clean energy stocks. (Lundgren et al., 2018). A weaker effect of policy uncertainty in comparison to uncertainty from the financial market and the oil market on the stock returns of the energy stocks (Ji et al., 2018). The "structural vector autoregressive" (VAR) model was used to examine the effect of oil price shocks and policy uncertainty on the stock returns of clean energy companies (Rahman et al., 2018). The study found a positive impact of oil supply and aggregate demand shocks and a negative effect of policy uncertainty and oil-specific demand shocks on the return of the clean energy companies during a sample study period of 2001-18. Further, the paper highlighted the uncertainty of inflation as a major source of policy uncertainty. A negative impact of COVID-19 on the stock market indices of the clean energy sector (S. Ghosh, 2022). Their findings

described how the uncertainty caused by COVID-19 and geopolitical indices influences the renewable energy market. The impact of uncertainty on the volatility and return of renewable energy stocks and the positive impact of economic policy uncertainty on the returns of the renewable stocks (Ige et al., 2022). The energy news and economic policy uncertainty are critically interconnected in the US economy (Guinea et al., 2024). The extreme shocks indicate the weaker relationship between "Wilder Hill Clean Energy index" (NEX) and "West Texas Intermediate oil futures" (Xi et al., 2022). The clean energy stocks are the main contributors and recipients in the short-run dynamic system (Qi et al., 2022; Zhang et al., 2023). The climate or economic policy uncertainty shocks significantly affected the energy stocks in the European stock market (Tedeschi et al., 2024; Wang & Kong, 2022). During the pandemic the energy stock was affected significantly due to the policy uncertainty (Hemrit & Benlagha, 2021)

After reviewing the literature, we did not find any event study that has been conducted to examine the effect of government policy on the stock returns in the solar energy sector. Hence, conducting this study will assist the various stakeholders to assess the market reaction well in advance; therefore, it motivates us to conduct such a study.

This study examines the impact of news related to sustainable energy solutions under "PSY" on energy stocks listed on the "National Stock Exchange" (NSE). The review of literature supports the idea that the new information significantly impacts stock returns. Following the objective of the study, the null hypothesis has been formed as:

H_1. The news information does not significantly impact the energy sector stock returns during the event window.

H_2. The news information does not significantly impact the energy sector stock returns during post-event window.

3. Data and research methodology

3.1. Data

To examine the formed objective, we need to extract the data from the source, which gives authentic and accurate data. For this purpose, we have extracted the historical data from the official website of the NSE (www.nseindia.com). Although we can extract it from the "Bombay Stock Exchange," it is preferred to extract it from the national-level stock exchange (Rai & Pandey, 2022a). There are ten stocks listed in thematic/sectoral-based energy stocks in the NSE (Table 1). We need to find alpha and beta to calculate the normal return based on the benchmark index; therefore, we have extracted the energy index for the same.

Table 1. List of stocks taken for study

Sl. No.	Listed Stocks	Sl. No.	Listed Stocks
1	"Adani Energy Solution Limited"	6	"Power Grid Corporation of India Limited"
2	"Bharat Petroleum Corporation Limited"	7	"Reliance Industries Limited"
3	"Indian Oil Corporation Limited"	8	"Coal India Limited"
4	"Adani Green Energy Limited"	9	"NTPC Limited"
5	"Tata Power Company Limited"	10	"Oil and Natural Gas Corporation Limited"

Source: www.nseindia.com

3.2. Methodology

We have used the standard event study methodology (Brown & Warner, 1980, 1985) to examine the impact of news related to sustainable energy solutions under "PSY" on energy stocks. We need to fix the "event date, estimation window, and event window". This news was announced on 22 January 2024, but on the day the stock market was closed, therefore, it shows its impact on the next trading date, i.e., 23 January 2024, which became the event date. We have used a 90-day "estimation window" (t-100 days to t-11 days), whereas the "event window" includes a period of 21 days, including event day (t-10 days to t+10 days) (Rai &

Pandey, 2022b). Further, we have used 30 30-day post-event window, i.e., (t+11 days to t+40 days), to examine the post-event effect of the policy of energy stocks.

Further, we need to find out the estimated normal stock return using a standard estimation model. The "ordinary least squares" (OLS) estimation model is most popular and widely used for the estimation of normal stock returns under the "event study methodology" (Brown & Warner, 1980, 1985; Pandey et al., 2021; Pandey & Kumari, 2021b; Rai & Pandey, 2022a; Thomas Dyckman, 1984). Therefore, we have used a market model to estimate the normal return (N_{Rit}) and calculate the abnormal return (A_{Rit}) by subtracting the normal return (N_{Rit}) from the actual return (R_{it}) of the stocks Equation (1).

$$A_{Rit} = R_{it} - (\alpha + \beta R_{mt}) \quad (1)$$

where, A_{Rit} and R_{it} are the abnormal and actual return of stock 'i' on day t, α is the intercept, and β is the slope of the OLS model, R_{mt} is the benchmark index return of selected stocks on day t**.** To get a more accurate price, we calculate the log return of the closing price (R_{it}), (eq.2) where (CP_{it}) closing price of stock 'i' on day t (CP_{it-1}) is the closing price of stock 'i' on day *t-1*.

$$R_{it} = logN\left(\frac{CP_{it}}{CP_{it-1}}\right) \times 100 \quad (2)$$

The calculated abnormal return of individual sample stocks is aggregated to get the average abnormal return (AAR) by dividing the aggregated value by the number of stocks taken for the study Equation 3), and this AAR is used to calculate the cumulative average abnormal return of the stock. Further, to test the statistical significance of the hypothesis, we calculate the t-value of the AAR and CAAR (see Equation (4) and Equation (5)) which will be compared with the above-mentioned tabulated t-value at given level of significance and degree of freedom (Table 2) to give concrete decisions by accepting or rejecting the hypothesis.

$$AAR_t = \frac{1}{N}\sum_{t=1}^{N} AR_{it} \quad (3)$$

$$AAR_t t = \frac{AAR_t}{\sigma N_{et}} \quad (4)$$

$$CAAR_t t = \frac{CAAR_t}{\sigma N_{et}\sqrt{N_{t+1}}} \quad (5)$$

Where AAR_t and $CAAR_t$ are the average abnormal return and the cumulative average abnormal return on day t. $\sqrt{N_{t+1}}$ is the absolute value of the event day plus one. σN_{et} is the aggregated standard deviation of the selected sample of stocks (N) for the estimation period, Equation (6).

$$\sigma N_{et} = \sqrt{\frac{\sum_{i=1}^{N}\sigma_{iet}^2}{N^2}} \quad (6)$$

4. Discussion and Analysis

4.1. Event window period

Table 3 represents the daily AARs and CAARs for the 21-day event window. The study of empirical results shows the presence of 30 negative abnormal returns during the window period. In addition, negative abnormal returns were also present during the event day. The presence of insignificant AARs on all the trading days highlights the weaker effect of policy uncertainty during the pre-event period. The results are in line with Ji et al. (2018). During the post-event period, a single average abnormal return is significant at a 5% level, i.e., on t+3. It may be attributed to the tensions in the Middle East and the related geopolitical risk that forced investors to pull out their money from the energy stocks.

Table 2. Critical t value at 1%, 5%, and 10% level of significance

Sector	N	*df*	t-stats at different levels of significance		
			1%	5%	10%
Energy	10	9	-3.25 to +3.25	-2.26 to +2.26	-1.83 to +1.83

Notes: N = sample size, df = degree of freedom

The cumulative average abnormal returns are significant on a single trading day, i.e., t+3, at the 10% level of significance. The results are in line with the prior literature. Further, the presence of non-significant abnormal returns during pre-policy announcement on the majority of the trading days implies that the market had no information leakage. However, the presence of significant negative cumulative AAR on t+3 and significant AAR on t+3 and t+4, which is equally distributed between positive and negative effects. The trading day recalls a need to study the shorter window period, as it can reveal the pre- and post-effect of the announcement in a better way in comparison to the longer window period. The result highlights no significant effect of the government policy announcement on the return of the energy stocks.

Table 3. Daily AAR and CAAR during the 21-day event window

Days	AAR	AARt	CAAR	CAARt
t-10	0.19	0.30	0.19	0.09
t-9	-0.51	-0.83	-0.33	-0.17
t-8	-0.69	-1.11	-1.01	-0.54
t-7	-0.17	-0.27	-1.18	-0.67
t-6	-0.69	-1.12	-1.87	-1.14
t-5	0.84	1.36	-1.03	-0.68
t-4	0.19	0.31	-0.84	-0.60
t-3	0.15	0.24	-0.69	-0.55
t-2	-0.24	-0.39	-0.93	-0.86
t-1	0.83	1.33	-0.10	-0.11
t	0.36	0.59	0.27	0.43
t+1	-0.56	-0.91	-0.30	-0.34
t+2	-0.12	-0.20	-0.42	-0.39
t+3	-2.26	-3.64***	-2.68	-2.16*
t+4	1.28	2.06*	-1.40	-1.01
t+5	-0.60	-0.96	-1.99	-1.31
t+6	-0.02	-0.04	-2.02	-1.23
t+7	-0.69	-1.11	-2.70	-1.54
t+8	0.30	0.48	-2.40	-1.29
t+9	0.87	1.40	-1.53	-0.78
t+10	0.35	0.57	-1.18	-0.57

Note: *** and * indicate significant at 1% and 10% levels, respectively.

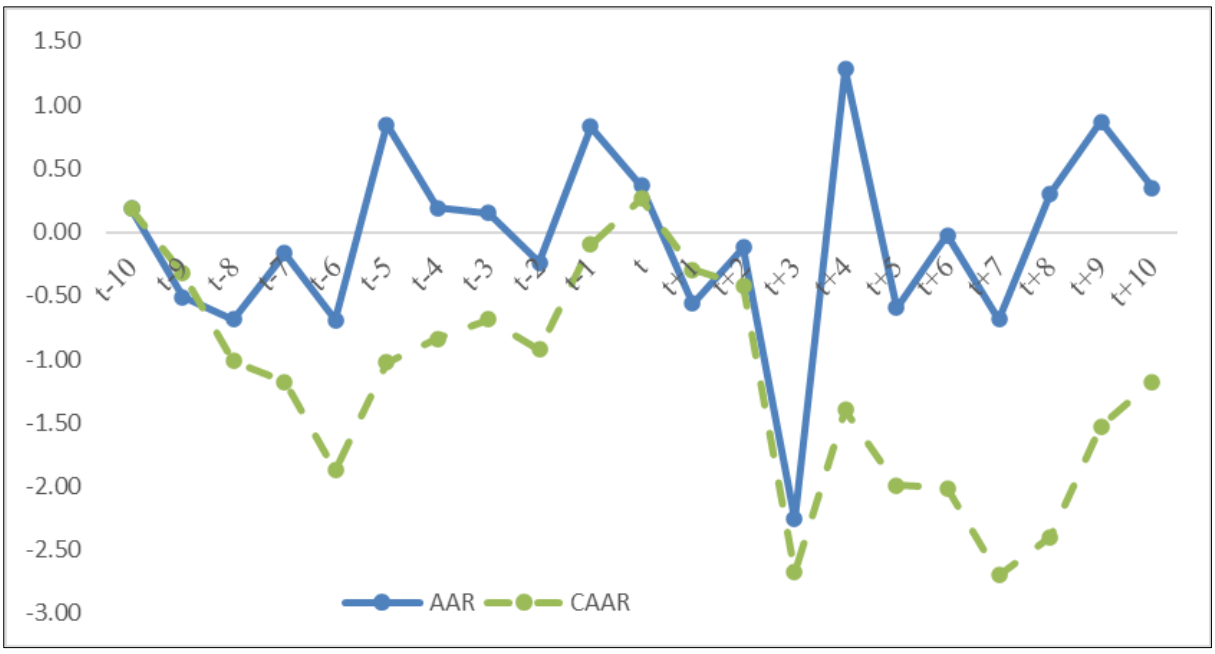

Figure 1. AAR and CAAR line of energy sector stock for a 21-day event window

Figure 1 presents the AARs and CAARs of the entire 21-day trading window. The result portrays a similar trend in AARs and CAARs before the government policy announcement of "PSY" and the gap between both trend lines diminishes as the event day approaches. Further, these lines overlap with each other at the start of the event and on the event day. After the event day, CAARs first declined sharply from t+2 days and later on followed a U-shaped recovery from t+4 to t+10 trading days. This implies that initially, news has a negative impact on the listed energy stocks. However, the negative effect of the government policy announcement on the energy stocks diminishes with the passage of time. Furthermore, given the positive AARs during the post-event period, it has been found that although the cumulative effects are negative, the policy announcement effect is positive. The results of the negative cumulative impact are in line with prior literature (Pandey & Kumari, 2021c, 2021a).

However, more information has been inferred from an analysis of a shorter window period. Thereby, we proceed with the analysis of AARs and Cumulative AARs around the event day with a shorter period.

4.2. Post-Event window

We have conducted an empirical analysis for the 30-day post-event window to examine the effect of policy announcements on energy stocks. Table 4 depicts the result that indicates a significant effect of policy announcement, although there is a mixed effect on energy stocks. The AAR has significant positive effects on t+11, t+15, t+16, t+18, t+23, t+29, t+30, t+33, and t+36 trading days and negative effects on t+12, t+13, t+14, t+20, t+25, t+34, t+35, t+38, and t+39 trading days. It shows the equal effect in both directions with 9 significant positive and 9 significant negative effects. When we examine the effect of CAAR, it has a positive effect on t+11 and t+33, while a negative effect on t+14 trading day. Figure 2 shows that the AAR is constantly fluctuating with a significant effect in the post-event window. The CAAR is hitting the AAR and overlaps t_{+30} onwards. Although the 30-day post-event window is too long to check the effect, other confounding effects may occur during the window (Ige et al., 2022).

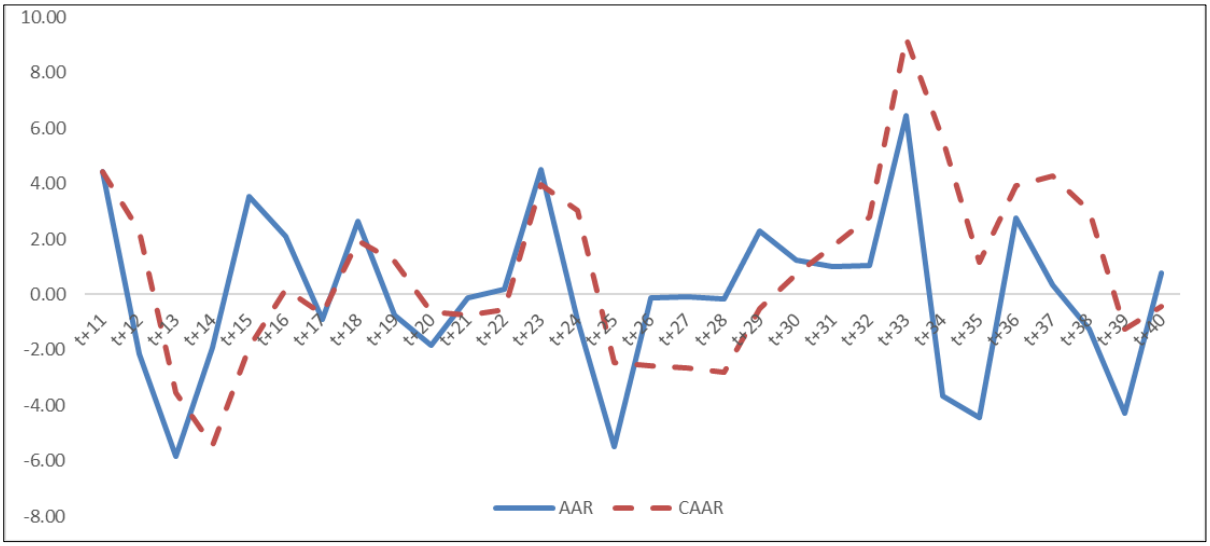

Figure 2. AAR and CAAR during the post-event window

5. Conclusion

The study examined the price behavior of 10 energy stocks listed in thematic/sectoral-based energy stocks in the NSE to inspect the impact of government policies on the Indian stock market (Rai & Pandey, 2022a). It is also a well-known fact that the effect of policy announcements on the stock market varies from country to country, and within a country, too, it varies from one sector to another. The empirical result rejects the null hypothesis,

highlighting the negative cumulative effect of the government policy announcement on the return of the energy stocks (see Table 5, for a summary of hypotheses). However, the negative effect of the government policy announcement on the energy stocks diminishes with the passage of time. The study also highlights the weaker effect of the policy uncertainty during the longer pre-event window period. This shows that the market had no clue or information in relation to the announcement of the "PSY". Furthermore, given the positive AARs during the post-event period, it has been found that although the cumulative effects are negative, the policy announcement effect is positive.

The presence of significant CAAR in the shorter pre-window period provides several insights to the investors. The presence of such significant returns indicates both the information leakage and the anticipation of the event regarding the event's occurrence, thereby reflecting market inefficiency (E. Fama, et al. 1969). The present study will assist the investors in building their portfolio during times of such policy uncertainty. It becomes easier for the investors to select a particular security for their portfolio once he/she know how the stock market reacts to such uncertainty. Further, the effects of other similar events on selected energy sector stocks can be examined to get concrete effects of particular events, and the cross-country effect can also be examined on global energy sector stocks.

Table 4. Daily AAR and CAAR during the post-event window

Day	AAR	AARt	CAAR	CAARt
t+11	4.42	7.14***	4.42	2.06*
t+12	-2.13	-3.43**	2.30	1.03
t+13	-5.84	-9.42***	-3.54	-1.53
t+14	-1.91	-3.08**	-5.45	-2.27**
t+15	3.55	5.73***	-1.90	-0.77
t+16	2.09	3.37***	0.19	0.07
t+17	-0.90	-1.44	-0.70	-0.27
t+18	2.64	4.27***	1.94	0.72
t+19	-0.75	-1.20	1.19	0.43
t+20	-1.83	-2.94**	-0.63	-0.22
t+21	-0.11	-0.18	-0.74	-0.25
t+22	0.18	0.29	-0.56	-0.19
t+23	4.51	7.28***	3.95	1.30
t+24	-0.93	-1.50	3.02	0.97
t+25	-5.49	-8.85***	-2.47	-0.78
t+26	-0.11	-0.17	-2.57	-0.80
t+27	-0.06	-0.10	-2.64	-0.80
t+28	-0.17	-0.27	-2.80	-0.84
t+29	2.29	3.69*	-0.51	-0.15
t+30	1.24	2.00*	0.73	0.21
t+31	1.00	1.62	1.73	0.49
t+32	1.06	1.70	2.79	0.78
t+33	6.47	10.43***	9.26	2.56**
t+34	-3.66	-5.91***	5.59	1.53
t+35	-4.45	-7.18***	1.15	0.31
t+36	2.78	4.48***	3.92	1.04
t+37	0.34	0.55	4.27	1.12
t+38	-1.23	-1.99*	3.03	0.78
t+39	-4.26	-6.88***	-1.23	-0.31
t+40	0.79	1.27	-0.44	-0.11

Notes: ***, **, and * indicate significant at 1%, 5%, and 10% levels, respectively.

Table 5. Summary of hypothesis decisions

Sr. No.	Hypothesis	Decision
H_1	There is no significant impact of news announcements on energy sector stock returns during the event window.	Accepted
H_2	There is no significant impact of news announcements on energy sector stock returns during the post-event window	Rejected

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