The effect of the Japan 2011 disaster on nuclear and alternative energy stocks worldwide

October 11, 2011 · University of Georgia · Athens, GA

Robert Ferstl* · Sebastian Utz† · Maximilian Wimmer†

*Oesterreichische Nationalbank (OeNB), Vienna, Austria
†Department of Finance, University of Regensburg, Germany
Motivation

The effect of the Japan 2011 disaster on nuclear and alternative energy stocks worldwide

Date

Index

S&P Global Nuclear Energy Index

S&P Global Clean Energy Index
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Motivation

The graph illustrates the index values of two energy sectors: S&P Global Nuclear Energy Index and S&P Global Clean Energy Index. The vertical line marks the date of the tsunami (03/11/11), highlighting the significant impact on the nuclear energy sector. The graph shows a sharp decline in the nuclear energy index and a more muted reaction in the clean energy index, indicating the complexity and varying responses to the disaster in different energy sectors.
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2 Methodology

3 Data and Results

4 Conclusion
Outline

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1 Literature Review

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4 Conclusion
Related Literature—Three Miles Island, March 1979

- **Bowen et al. (1983), J. Finan. Quant. Anal.**
  - Data: Daily U.S. utility stock prices
  - Negative abnormal returns, esp. for nuclear-related firms
  - Upward shift in market risk

- **Hill and Schneeweis (1983), J. Finance**
  - Data: Monthly U.S. utility firms stock prices
  - Negative abnormal returns 1–2 months after TMI for nuclear firms
  - No significantly abnormal returns for non-nuclear firms

- **Barrett et al. (1986), J. Finance**
  - Data: U.S. utility bond prices
  - Increase in risk premia, esp. for nuclear-related firms
Related Literature—Chernobyl, April 1986

  - Data: Daily U.S. electric utility stock prices
  - Negative abnormal returns during a 20-day period after Chernobyl, esp. for nuclear-related firms
  - No significant upward shift in market risk

- **Kalra et al. (1993)**, Quart. J. Bus. Econ.
  - Data: Grouped U.S. utility stocks by their nuclear capacity
  - Negative returns in all groups
  - Mixed group with 10–20% nuclear capacity performs worst

- **Aktar (2005)**, Sosyoekonomi
  - Data: U.S. electric utility stocks
  - Chernobyl: Greater impact for firms with nuclear power plants under construction
  - TMI: Greater impact for firms with plants near population centers
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Methodology

Event study methodology:

Fama and French (1993) model estimation period

Abnormal returns?

Event window

Post-event window

$t_0$
Jan 4, 2008

$t_1$
Mar 11, 2011

$t_2$
Mar 18, 2011

$t_3$
Apr 15, 2011

For a single asset, let

$$R_t = \beta_0 + \beta_M M_t + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \epsilon_t, \quad t = t_0, \ldots, t_3.$$  

In matrix form:

$$R = X\theta + \epsilon, \quad X = [1 \mid M \mid SMB \mid HML] \in \mathbb{R}^{(t_3 - t_0 + 1) \times 4}.$$  

Including dummy variables $D_{t_i}, t_i = t_1, \ldots, t_3$ for the (post-)event window:

$$R = X\theta + D\gamma + \epsilon, \quad D = [D_{t_1} \mid \cdots \mid D_{t_3}] \in \mathbb{R}^{(t_3 - t_0 + 1) \times (t_3 - t_1 + 1)}.$$
Methodology

- For $g$ different assets, let
  \[ R_i = X\beta_i + D\gamma_i + \varepsilon_i, \quad i = 1, \ldots, g. \]

- Stacked multivariate regression model (MVRM):
  \[
  \begin{bmatrix}
    R_1 \\
    R_2 \\
    \vdots \\
    R_g
  \end{bmatrix}
  = \begin{bmatrix}
    X & D & 0 & 0 & \cdots & 0 & 0 \\
    0 & 0 & X & D & \cdots & 0 & 0 \\
    \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
    0 & 0 & 0 & 0 & \cdots & X & D
  \end{bmatrix}
  \begin{bmatrix}
    \beta_1 \\
    \gamma_1 \\
    \vdots \\
    \beta_g \\
    \gamma_g
  \end{bmatrix}
  + \begin{bmatrix}
    \varepsilon_1 \\
    \varepsilon_2 \\
    \vdots \\
    \varepsilon_g
  \end{bmatrix}.
  \]

- **Hein and Westfall (2004)** bootstrap test statistic of the linear hypothesis matrix $A$:
  \[ S = (A\hat{\delta})'(A(\Xi'(\hat{\Sigma} \otimes I_{t_2-t_0+1})^{-1}\Xi)^{-1}A')^{-1}(A\hat{\delta}). \]

  - Robust to non-normal i.i.d. residuals
  - Adjusts for cross-sectional correlations
Hypotheses

\( H_1 \): The event does not affect the abnormal returns of the nuclear energy stocks in the (post-)event window.

\( H_2 \): The event does not affect the abnormal returns of the alternative energy stocks in the (post-)event window.

\( H_3 \): The event does not affect the cumulative abnormal returns of the nuclear energy stocks in the (post-)event window.

\( H_4 \): The event does not affect the cumulative abnormal returns of the alternative energy stocks in the (post-)event window.
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Data—Fama-French model estimation

- Thomson Reuters Datastream:
  - Price Adjusted \( P \) as stock price
  - Market Value \( MV \) as market value
  - Common/Shareholder Equity \( WC03501 \) as book value

- Calculate market portfolio, SMB portfolio, HML portfolio similar to Fama and French (1993), but use median of the market capitalization of all stocks in the respective market as of June 30 as the threshold for the SMB portfolio

- France: NYSE Euronext (295 stocks, €1.242 trillion)
- Germany: Börse Frankfurt (230 stocks, €907 billion)
- Japan: Tokyo Stock Exchange (2,264 stocks, ¥309.522 trillion)
- United States: NYSE, AMEX, NASDAQ (3,876 stocks, $14.022 trillion)
Data—Sample selection

Nuclear firms

- min. 1,000 MW nuclear power capacity
- Domestic

Alternative energy firms

- Datastream classification
  Alternative Energy
- Liquidity requirements:
  - max. 90 days w/o trades during the estimation period
  - max. 5 days w/o trades during the (post-)event window
  - min. FF-model $R^2$: 15%

1 (FR) / 2 (DE) / 9 (JP) / 19 (US) stocks remaining

1 (FR) / 8 (DE) / 1 (JP) / 7 (US) stocks remaining
Results—Fama-French model fit

<table>
<thead>
<tr>
<th>Factor</th>
<th>Nuclear Stocks</th>
<th></th>
<th></th>
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<th>Alternative Energy Stocks</th>
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<td>Germany</td>
<td>Japan</td>
<td>USA</td>
<td>France</td>
<td>Germany</td>
<td>Japan</td>
<td>USA</td>
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<tr>
<td>$\beta_M$</td>
<td>0.91 (0.00)</td>
<td>0.81 (0.13)</td>
<td>0.40 (0.04)</td>
<td>0.72 (0.15)</td>
<td>1.13 (0.00)</td>
<td>1.87 (0.51)</td>
<td>1.17 (0.00)</td>
<td>1.47 (0.39)</td>
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<tr>
<td>$\beta_{SMB}$</td>
<td>-0.01 (0.00)</td>
<td>-0.14 (0.05)</td>
<td>-0.07 (0.05)</td>
<td>-0.35 (0.14)</td>
<td>1.14 (0.00)</td>
<td>0.99 (0.54)</td>
<td>1.18 (0.00)</td>
<td>0.62 (0.43)</td>
</tr>
<tr>
<td>$\beta_{HML}$</td>
<td>-1.00 (0.00)</td>
<td>-1.01 (0.17)</td>
<td>0.69 (0.10)</td>
<td>-0.36 (0.16)</td>
<td>-0.00 (0.00)</td>
<td>-0.84 (0.29)</td>
<td>0.50 (0.00)</td>
<td>-0.36 (0.44)</td>
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<tr>
<td>$R^2$</td>
<td>0.54 (0.00)</td>
<td>0.59 (0.03)</td>
<td>0.43 (0.16)</td>
<td>0.48 (0.08)</td>
<td>0.15 (0.00)</td>
<td>0.28 (0.10)</td>
<td>0.39 (0.00)</td>
<td>0.26 (0.09)</td>
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Table 1. Fama-French model fit (mean factors). Standard deviations are in parentheses.
Results

Figure 2. Correlation matrices of all nuclear and alternative energy stock residual returns in each country estimated by the MVRM. Red color equals 1, white color equals 0, and green color equals $-1$. 
Results

Figure 2. Correlation matrices of all nuclear and alternative energy stock residual returns in each country estimated by the MVRM. Red color equals 1, white color equals 0, and green color equals $-1$. 

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Data and Results | 18/25
### Table 2. Mean daily abnormal returns (in upright letters) and mean daily cumulative abnormal returns (in italic letters). *, **, *** denote joint significant (cumulative) abnormal returns at a 10%, 5%, and 1% level, respectively.
### Results

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<td>E.ON</td>
<td>RWE</td>
<td>C3O</td>
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<td>1.5</td>
</tr>
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<td>-4.5**</td>
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<td>March 15</td>
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<td>-1.6</td>
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<td>March 16</td>
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</tr>
<tr>
<td>March 17</td>
<td>-0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>March 18</td>
<td>-1.5</td>
<td>-0.6</td>
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Table A.3. Daily abnormal returns of nuclear and alternative energy companies in Germany.
## Results

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<td>−0.3</td>
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<td>−2.9*</td>
<td>−4.7***</td>
<td>−2.6*</td>
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**Table A.4.** Daily abnormal returns of nuclear and alternative energy companies in Japan.
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Results

<table>
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<tr>
<th>Date</th>
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<th>FE</th>
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Data and Results

Department of Finance
University of Regensburg

Table A.5. Daily abnormal returns of nuclear and alternative energy companies in the USA.
Outline

0 Motivation

1 Literature Review

2 Methodology

3 Data and Results

4 Conclusion
Conclusion

- Effects of the event are incorporated into stock prices within a few days

  Semi-strong market efficiency

- High volatility for Japanese stocks
- Policy change towards alternative energies expected in France and Germany
- No forthcoming policy departure expected in the United States