Energy stock returns and the Fukushima Nuclear Accidents

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Abstract

In this paper, we investigate the reaction of energy stock prices to the accidents and to the government responses. We examine both the market reaction soon after the accidents, and the period thereafter when the Institution Supporting Compensation for Nuclear Damages Act was passed and signed into law. TEPCO's stock price lost the largest for direct damage of its nuclear plants in Fukushima. Also nuclear business stock prices drooped. We find that the more a power company depends on nuclear energy; its stock price dropped more after the accident. In contrast, alternative energy stock prices gained from the accident. The abnormal returns depend on business compositions of energy stocks and nuclear business stocks. We find that the market believes the primary beneficiary of the Act was TEPCO but other power companies did not gained much.

JEL classification: G14, G12, G15, Q48, Q54, G38

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1. Introduction

On March 11, 2011, the Fukushima nuclear disasters occurred after a 9.0 magnitude North East Japan earthquake and subsequent tsunami. The Fukushima accident triggered a political discussion about the social and political perception of nuclear power, and therefore caused costs of stricter regulation and safety requirements and/or costs of a nuclear power phase out.

There are several studies in finance literature, which focus upon the consequences of nuclear disasters such as the Three Mile Island (TMI) accident in March 1979 and the Chernobyl disaster in April 1986 on stock prices. Some studies investigate the market reactions to nuclear accidents (Hill and Schneeweis, 1983; Bowen, Castanias and Daley, 1983; Barrett, Heuson and Kolb, 1986; Pruitt, Tawarangkoon and Wei, 1987; Fields andJanjigian, 1989; Kalra, Henderson and Raines, 1993) and the other focus on the impact on risk and/or beta shifts like around nuclear accidents (Chen, 1984; Uselton, Kolari and Fraser, 1986; Chandy and Karafiath, 1989; Spudeck and Moyer, 1989).

To the best of our knowledge, currently there are four studies that investigate the effect of the Fukushima accident on market reactions and analyze parameter shifts. First, Mama and Bassen (2011) investigate the intra-industry information transfers in the European and Japanese electric industry in the wake of the Fukushima nuclear accident. They find that conventional utilities (e.g. oils, gas and nuclear utilities) generally suffered significant market value losses as a result of the nuclear accident. The impacts are, however, not homogeneous in Japan and in Europe. The shock seems to be long-lasting and follows either the gradual political response to the accident or the piecemeal information of TEPCO about the seriousness of the accident. The market value losses in Europe appear to be extremely short-lived and the share prices of European alternative utilities (non-conventional utilities) seem to have permanently been bolstered by the accident. In addition, Japanese utilities (including TEPCO) are homogenously and adversely affected by the accident. Furthermore, they find an increase in the systematic risk of conventional utilities as well as a decrease in alternative utilities following the event. For Europe, they document a decrease in the idiosyncratic risk of conventional utilities and that total risk seems to be stationary around the accident. Meanwhile, idiosyncratic and systematic risks have substantially risen in Japan since the event. On the other hand, intercept values related to European utilities remained stable around the accident while Japanese utilities incurred a substantial decline in their daily average returns as captured by alpha shifts.

Based on a three-factor model, Ferstl, Utz and Wimmer (2011) investigate the impact of the Japanese nuclear disaster in Fukushima- Daiichi on the daily stock prices of French, German, Japanese, and U.S. nuclear utility and alternative energy firms. They jointly test hypotheses regarding the abnormal returns by multivariate regression models and bootstrapping methodology. Their results show significant abnormal returns for Japanese nuclear utility firms during the one-week event window and the subsequent four-week post-event window. Furthermore, they find that while French and German nuclear utility and alternative energy stocks exhibit significant abnormal returns during the event window, U.S. stocks show no significant abnormal returns.

With a slightly different focus, Betzer, Doumet and Rinne (2011) highlight German reaction to the Fukushima Daiichi nuclear disaster. Using the event study methodology, they find that a wealth transfer from nuclear energy companies to renewable energies companies in Germany. Moreover, they find that the joint market capitalization of these firms has decreased, but the overall loss in terms of the joint market capitalization is small. They point out that substantial heterogeneity in the shareholder wealth effects across European countries can be linked to different nuclear energy policies. Also, they document that the shareholder wealth of nuclear and conventional energy companies in the United States has been unaffected.

The above three studies investigate the impact of the nuclear crisis on stock prices of firms that produce nuclear and conventional power and companies that produce solely power from renewable resources. Using hand-collected the percentages of revenues that are generated by nuclear power and renewable energies within a company, Lopatta1 and Kaspereit (2012) highlight the roles of renewable energies as an instrument of diversification for the risks of being engaged in the politically controversial nuclear power business. Their study is based on a sample of firms that are registered as owners or operators of nuclear power plants in the Power Reactor Information System (PRIS) of the International Atomic Energy Agency (IAEA). They find that the higher was the decline in share price depends on nuclear power percentage of a firm after the accident. But they find no evidence that a firm's commitment towards renewable energies serves as an instrument of diversification. Their results also indicate that an announced nuclear phase out by the political regime leads to an increase in negative abnormal returns if the company is domiciled in this country.

In this paper, we investigate the reaction of energy stock prices to the accidents and to the government responses. We examine both the market reaction soon after the accidents, and the period thereafter when the Institution Supporting Compensation for Nuclear Damages Act was passed and signed into law. In this investigation, we use the multivariate regression model methodology (MVRM) to investigate the market's reaction to the disasters. Furthermore, we investigate cross-sectional differences in abnormal returns. By examining the period when the Institution Supporting Compensation for Nuclear Damages Act was passed and signed into law (August 10, 2001), we explore whether the market believes the primary beneficiaries of the Act were the major power companies.

Our contribution to prior event studies on nuclear disasters is fourfold. Firstly, to our best knowledge, it is the first analysis on the Institution Supporting Compensation for Nuclear Damages Act. For the Fukushima accident in March 2011, the Japanese government has set up a state-backed authority in charge of receiving financial contributions from nuclear electric utilities and from the government. We provide evidence that the nuclear power related utilities benefit from this loss sharing scheme for the Fukushima accident. The previous study analyze the policy changes that came along with the Fukushima disaster and investigated the impact of the German reaction on shareholder wealth of energy firms and firms in the green economy.

Secondly, our data consists of a broader sample regarding nuclear power business. We examine the differences concerning the impact on stock prices among power companies, the listed subsidiaries of power companies, nuclear reactor construction related companies, gas companies and alternative energy companies, while former studies focus on nuclear related utility stocks and alternative energy companies. Also, our Japanese alternative energy stocks are not included in previous studies. Our analysis confirms the results from prior studies that a nuclear accident yields a decline in Japanese utility stock prices. And we examine both statistically and economically significant positive abnormal returns on Japanese alternative energy stocks. In addition, we present evidence that nuclear reactor construction stocks lose from a nuclear accident.

Thirdly, the situation at Japan's Fukushima Daiichi nuclear plant has been changing rapidly and growing increasingly complex since the earthquake and tsunami hit on March 11. Problems began that day, and each day has brought new, unsettling developments. Also, TEPCO's stock price fell (rose) by maximum allowed limit on the Tokyo Stock Exchange following good (bad) news on March 14 and March 30. It might underestimate abnormal return if daily returns are used. To control for the problem of maximum allowed limit, we use weekly returns, instead of daily returns. Also, we find no shifts in systematic risk/beta for regulated utilities.

Fourthly, we take a close look at the impact of the Fukushima nuclear disaster on the Japanese utility stocks and Japanese alternative energy stocks. Japanese utilities (including TEPCO) are not homogenously affected by the accident. Even the abnormal returns between two directly damaged utilities are not uniform. Focusing on Japanese firms, we find that the coefficient on the exposure to nuclear power is statistically significant and also the economical significance is much stronger than that in previous studies.

The paper proceeds as follows: Section 2 describes the financial impact of the March 11 nuclear accidents and the Institution Supporting Compensation for Nuclear Damages Act. Section 3 describes the data sources and the empirical methodology used in the investigation. Section 4 presents the results, and Section 5 concludes.

2. The financial impact of Fukushima nuclear accident and the Institution Supporting Compensation for Nuclear Damages Act

2.1 The financial impact of the Fukushima nuclear accident

World Bank reports the massive earthquake and tsunami in northeast Japan caused up to $235 billion in damages and it is one of the most expensive in modern history. It will cost far more than earthquakes in Haiti last year and Kobe in 1995, as well as Hurricane Katrina along the Gulf Coast in 2005 and the tsunami in South Asia in 2004. The natural disaster turned into one of the largest nuclear energy disasters the world has seen on Day 2 of the disaster, March 12, when the first Fukushima nuclear reactor exploded. Even worse, the earthquake and tsunami damaged Japanese nuclear power plant, as a huge relief operation continues after Friday's devastating earthquake and tsunami. The disaster had serious financial consequences for power companies which were operating nuclear plants. Goldman Sachs Japan Co. estimates that TEPCO faces an extraordinary loss at $8.75 billion (¥700 billion)[1] to decommission the damaged reactors and a $6.25 billion increase in fuel costs in 2011 fiscal year. And, the government estimates a $72.5 billion (¥5.8 trillion) liability. Additionally, the decontamination costs are predicted to exceed $12.5 billion (¥1 trillion). Furthermore, stricter regulation, shutdown of nuclear plants to carry out new safety check, nuclear energy moratorium, a nuclear

[1] Throughout the paper, exchange rate is $1=¥80.

energy phase out would increase losses, particularly for utilities with larger exposure to nuclear energy. Meanwhile, increasing costs of nuclear energy would yield substitution between nuclear energy and alternative energy, thereby alternative energy stocks gain from the accident.

2.2 The Act on Institution Supporting Compensation for Nuclear Damages

Under the Act on Compensation for Nuclear Damage[2], the operator shall be liable for the damage, except in the case of an extraordinary natural disaster or an insurrection (Section 3(1)). Also, the operator shall provide a financial security by purchasing liability insurance with an indemnity agreement for compensation of nuclear damage or by providing a deposit, approved by the Minister for Education, Culture, Sport, Science and Technology (MEXT) for compensation of nuclear damage (Section 6 and 7). ¥120 billion yen for financial security is required for each installation or site or nuclear ship. When the actual damage exceeds the financial security amount or the operator is exonerated from the liability for nuclear damage, the Government shall provide aid to relieve victims and to prevent the damage from spreading (Section 16 and 17).

It is arguable that TEPCO should be exempted or not. But the amount of damages is so large that it is expected TEPCO by itself cannot afford it. As a response to TEPCO's affordability, the government enacted a new act called Act on Institution Supporting Compensation for Nuclear Damages (*Genshiryoku Songaibaisho Shienkikou Hou* in Japanese)[3]. The bill of Act on Institution Supporting Compensation for Nuclear Damages was adopted by the Cabinet on June 14. The bill was revised pressured by the opposition parties, however. The new bill mentioned that the government will consider a loss sharing scheme among the government, the

[2] The OECD Nuclear Energy Agency provides a detailed review of a full range of nuclear law topics in OECD countries, including nuclear damage liability.

[3] See Morita (2012) for details.

shareholders and other stakeholders. Also, the government will reconsider nuclear energy regulations. The revised bill is less favored for power companies. the revised bill was passed the special committee of the House on July 25 and passed the Diet on August 3. For the Fukushima accident in March 2011, the Japanese government has set up a state-backed authority in charge of receiving financial contributions from nuclear electric utilities and from the government (Section 38 and 48). Since TEPCO will be bailed out by the financial support from the institution, the shareholders, the general unsecured creditors (mainly financial institutions), and the power company bond holders (senior creditors), as well as the victims have benefited by the solution. If the benefits of the increased likelihood of bail out exceed the costs to support TEPCO, other power companies also benefited from the solution. Otherwise, other utility stock prices would drop.

3. Data and methodology

3.1. Sample firms and data

To investigate market rationality in the wake of the March 11 Fukushima Nuclear Accident, we use a sample of Japanese energy firms. First, we take business specifications from Toyo Keizai Japan Company Handbook. We obtain stock returns, financial data and segment data, used in this analysis, from the Nikkei Financial Quest. We eliminate firms with missing data. The resulting sample consists of 10 electric power companies and their nine listed subsidiaries, two firms with electric power wholesale business, seven gas companies, four nuclear construction companies, six wind power, clean energy and green energy companies. Table 1 presents descriptive data for the firms in our sample, including related business areas, in addition to various accounting measures, such as total assets, return on assets, etc.

3.2. Empirical methodology and hypothesis testing

We use the multivariate regression model (MVRM) methodology, first suggested by

Gibbons (1980), and further developed by Shipper and Thompson (1983), Binder (1985a, 1985b), and Malatesta (1986), to examine the market's reaction to the March 11th disaster. Multivariate regression is related to Zellner's seemingly unrelated regressions (SUR) technique and is frequently employed to examine events that simultaneously affect firms in the related industries. In these cases, stock return residuals will not be independently and identically distributed. For this reason, the MVRM approach is preferred to the standard event-study method first employed by Fama, Fisher, Jensen, and Roll (1969). Therefore, we estimate a system of equations in which the returns for each of our sample firms are represented as follows:

$$Ri,t = ai + a1iDs + biRm,t + b1iDsRm,t + ti,jDj + policyi,kDk + \varepsilon i,t$$

where Ri,t is the return on firm i in week t; Rm,t is the return on the TOPIX value-weighted market index in week t; αi, bi are the standard market-model parameters for each firm i; $\alpha si, \beta si$ are market-model parameters reflecting a risk shift; Dj is a dummy variable equal to 1 in event week j and 0 otherwise; Ds is a dummy variable used to capture any risk shift after March 11; ti,j is the abnormal return for firm i in the accident event week j; pi,j is the abnormal return for firm i in the policy event week k and $\varepsilon i,t$ is a random disturbance term.

We include parameters (***ai,a1i,bi,b1i,ti,j, policyi,k***) to capture any shift in risk perceptions by market participants resulting from the Fukushima Nuclear Accident on March 11, 2011. Eq. (1) is estimated using returns for the 103-week period beginning January 10, 2010 (w−61) and continuing through December 25, 2011 (w+41). We include four dummy variables for each of the weeks over the period of March 14–April 10. This period captures the market's reaction to the accidents when trading started on March 14. We also include three dummies for each of the weeks when the proposed bailout bill was adopted by the Cabinet on June 14; the revised bill was passed the special committee of the House on July 25 and passed the Diet on August 3.

Within the MVRM framework, we can test a number of hypotheses. First, we test Hypothesis H1: *ti,j (policyi,k) = 0* for all *i* belongs a group for event *j (k).* This hypothesis is essentially the standard event-study test to determine whether significant abnormal returns occurred in response to any of the events. Rejection of H_1 suggests that the market viewed the accident as having important implications for energy industry and that the information was incorporated into share price. Given the nature of the event, we expect significantly negative abnormal returns to nuclear related stocks and positive abnormal returns to alternative energy stocks when the market started trading on March 14. For policy event, we expect TEPCO's stock price benefitted from the bailout policy and other utility stock prices rely on the benefits and the costs of the solution.

To determine whether the market reaction was the same for each firm or whether the market differentiated based on differences among the electric power firms (i.e., rational pricing), we examine hypothesis H2: *t1,j= t2,j=…=tn,j* A uniform response, indicated by a failure to reject H2, suggests a contagion effect in which all nuclear related firms were penalized equally. We expect that the abnormal returns rely on exposures to nuclear related business and composition of alternative energy.

4 Empirical Results

4.1 Abnormal returns

4.1.1 Power companies

Table 2 presents estimates of abnormal returns for each nuclear related and substitute energy firm. An examination of the results presented in Table 2 shows that all electric power companies exhibit significant negative abnormal returns during March 14–March 18. The abnormal returns range from -0.2% for HOKURIKU ELEC. POWER to −47% for TEPCO (TOKYO ELECTRIC POWER). Only TEPCO and TOHOKU ELEC. POWER exhibit significant negative abnormal returns. These two electric power companies had power plants damaged by the earthquakes and tsunamis. But, the magnitude of the abnormal return for TOHOKU ELEC. POWER is much less than that for TEPCO. The hypothesis that the abnormal returns between the two stocks were uniform is rejected at the 1% level (F (1, 92) = 11.31). This suggests that the market believed the damage of the nuclear accident of TEPCO was much larger than damaged power plants of TOHOKU ELEC. POWER. Other electric power companies' stocks, however, did not drop significantly. We examine the hypothesis that whether significant abnormal returns occurred among electric companies other than TOHOKU ELEC. POWER and TEPCO. The hypothesis can not be rejected at the10% level (F(7, 92) =1.21). These results suggest that the market does not price all electric power firms the same way. This is important because it lends support to the hypothesis that rational pricing existed for electric power firms in the aftermath of the March 11th Fukushima Daiichi accidents

The situation at Japan's Fukushima Daiichi nuclear plant has been changing rapidly and growing increasingly complex since the earthquake and tsunami hit on March 11. Problems began that day, and each day has brought new, unsettling developments. By March 23, external power had reached most of the units. And workers were pumping water into the cores of Units 1, 2 and 3 and adding water to the spent fuel pools at 3, 4, 5 and 6. Each reactor has a used fuel pool in the upper level of their buildings. In the second week, no electric power companies exhibit significant negative abnormal returns. The hypothesis that no significant abnormal returns among the electric power companies cannot be rejected at the 10% level (F (9, 92) = 1.10).

But it is not the end of the accident. The market was waiting for more and information the resolutions of the accident. On March 26, the Japanese government urged TEPCO to be more transparent in sharing information with the public. And radiation had been making its way into milk, seawater and 11 kinds of vegetables, including broccoli, cauliflower and turnips. However, at a news conference TEPCO Chairman Tsunehisa Katsumata announces that it is unclear how the problems at the plant will be resolved on March 30. Also, he declared that TEPCO was compelled to decommission Fukushima I Nuclear Power Plant (Daiichi). Until this movement, TEPCO never declared the possibility to decommission the nuclear power plant. In other words, no damage was believed to have been sustained to the reactor itself. It sent a clear message to the market that TEPCO is liable not only for huge costs for decommissioning the nuclear power plant, but also for at minimum trillions of yens of damages as a tort-feasor. As the above information being incorporated into share price, all electric power stocks exhibit significant negative abnormal returns at the 5% level, 1% level respectively, except Okinawa Electric Power. Significant abnormal returns range from -7.4% for HOKKAIDO ELEC. POWER to -45.4% for TEPCO. TEPCO's stock price drooped from 2,121 JPY before the accident to 449 JPY at the end of the third week after the accident. But the magnitudes of the abnormal return for other electric power companies range from -7.4% to -9.4%. They are much less than that for TEPCO. The uniform response hypothesis among the nine electric companies is rejected at the 1 % level (F(9, 92)=4.41). It is worth noting that Okinawa Electric Power has no nuclear power plants. The hypothesis that no significant abnormal return for Okinawa Electric Power can not be rejected at the 10% level (F(1, 92)=1.27). Our findings support the hypothesis of rational pricing and suggest that the market differentiated among various electric power companies. The market was concerned about the increased likelihood of nuclear accidents in the wake of the Fukushima Daiichi nuclear accidents.

Now, we turn the effects of Institution Supporting Compensation for Nuclear Damages Act. The bill of Institution Supporting Compensation for Nuclear Damages Act was adopted by the Cabinet on June 14; the revised bill was passed the special committee of the House on July 25 and passed the Diet on August 3. The effect of this solution was substantial. Since TEPCO will be bailed out by the financial support from the institution, the shareholders benefited from the solution. All electric power companies exhibit significant positive abnormal returns. The abnormal return of TEPCO reached a 61.9% high. Although TEPCO is liable for the Fukushima Daiichi accident, the act adopted a loss sharing scheme that other power companies are forced to support TEPCO. Nonetheless, other power companies also benefited from the solution. The benefits of the increased likelihood of bail out exceed the costs to support TEPCO. The abnormal returns range from 7.5% to 21.5% for other power companies. The hypothesis that no significant abnormal returns among the electric power companies is rejected at the 1% level (F(10, 92) = 15.66). This can be interpreted that potentially the act increases the possibilities for the government to bailout power companies in case of nuclear accidents or other accidents. These are much less than that for TEPCO. But all power companies were not benefitted equally and a uniform response hypothesis is rejected at the 1% level (F (9, 92) =15.34).

The bill was revised pressured by the opposition parties, however. The new bill mentioned that the government will consider a loss sharing scheme among the government, the shareholders and other stakeholders. Also, the government will reconsider nuclear energy regulations. The revised bill is a little bit less favored for power companies. TEPCO exhibits a -17.6% abnormal return with significance at the 5% level. The abnormal returns for other power companies range from -5.6% to -8.5%. We examine the hypothesis that the abnormal returns in response to the revision are jointly zero and it cannot be rejected at the 10% level (F (10, 92) = 1.45). This suggests that the revision does not take away the benefits of bailout.

Not surprising, all power companies have no significant shifts in risk (b1_rate_topix) after the accident. Before the accident, the power companies' returns were not sensitive to the market return. Looking at the Institution Supporting Compensation for Nuclear Damages Act, it is not difficult to understand that power companies are like state owned enterprises. Usually, consumers pay the electricity bill and pay for losses of monopolistic power companies. This time, the losses of the nuclear accident are too large to be shifted to consumers and it will be covered by the government. We examine the hypotheses that the power companies' returns are not sensitive to the market return before and after the accident. Either cannot be rejected at the 10% level ($F(10, 92) = 0.88F(10, 92) = 1.45$, $F(10, 92) = 0.84$).

4.1.2 Nuclear business companies

Now we turn to nuclear business companies. Rejection of no significant abnormal returns indicates that the first week abnormal returns for the different nuclear business firms after the accident are jointly non-zero. The abnormal returns range from -5.7% for TOSHIBA PLANT SYSTEMS & SERVICE to -16.1% for SHIN NIPPON AIR TECHNOLOGIES. We examine the hypothesis that the abnormal returns are equal to that of TEPCO and it is rejected at the 1% level. These results suggest that the accident had negative implications for nuclear business firms, but the magnitude of the implications was less that that for TEPCO. Japan's nuclear crisis spurred German to pledge a faster shift from nuclear power and seemed to thwart Italy's plans to reintroduce atomic energy. Several other European nations, from Finland to Switzerland, have turned more skeptical about nuclear energy after Friday's earthquake and tsunami crippled the Fukushima plant in the world's worst nuclear accident since the 1986 Chernobyl disaster.

In the next week, two nuclear business stocks turned to rise significantly. One soared by 18.8% and one rose by 13.8%. This suggests that the market was reconsidering the implications for nuclear business stocks. In the third week, the hypothesis that the abnormal returns among nuclear business stocks are jointly zero cannot be rejected at the 10% level. Following the second large decline of TEPCO's stock, the nuclear business stocks declined again. The abnormal returns are negative. Two companies' stock prices lost 10%. These results suggest that the market beliefs were complicated. A moderate nuclear accident would increase sales of nuclear business companies. But the meltdown would decrease future demand for nuclear power and have strong negative influences on nuclear power policies around the world. Indeed, the fallout from Fukushima continues. In May, the Swiss government decided to phase out nuclear power by 2034 after the Japan disaster shook public confidence in the industry, but said it will not shut any existing power plants prematurely. Meanwhile, Germany's coalition government has announced a reversal of policy that will see all the country's nuclear power plants phased out by 2022. In June 2011, Italian people voted overwhelmingly against nuclear revival following the meltdown.

4.1.3 Alternative energy stocks

Nuclear shortfall in energy mix has to be met by alternative energy such as thermal plants, hydroelectric plants, or renewable energy. Out of seven stocks, six stocks had positive abnormal returns. NPC which has No.1 world market share in equipment for manufacturing photovoltaic modules and KOBE STEEL which holds a thermal power station in Kobe rose respectively by 30%, by 17.8% significantly at the 1% level. JAPAN WIND DEVELOPMENT also rose by 26.2% without significance at the 10% but it continued to soar in the next week by more than 50% significantly at the 1% level. FIRST ENERGY SERVICE, a clean energy company’s stock price rose by 14.1% following the crisis, soared by 34.3% in the second week, gained 21.5% in the third week and got doubled in the forth week. WEST HOLDINGS, a green energy company’s stock price gained more than 20% consecutively for tow weeks.

The hypothesis that the abnormal returns are jointly zero is rejected for each week after the accident. These results suggest that the market believed that Fukushima accident had positive implications for alternative energy businesses. As mentioned above, Japan and other countries have turned more skeptical about nuclear energy after the earthquake and tsunami crippled the Fukushima plant in the world's worst nuclear accident since the 1986 Chernobyl disaster. So far, it had been believed that nuclear energy is clean, cheap and safe. But the safety myth collapsed. The market believed that alternative energy would increase its comparative advantage. Also, a uniform reaction hypothesis is rejected. Green energy and wind power were more favored by the market.

Nuclear shortfall in energy mix has to be met mainly by gas. However, the abnormal returns among gas stocks are not so clear cut. As regulated utilities, the market doubted gas companies were motivated to compete with power companies. Also, it is less likely for regulated gas companies' shareholders to enjoy upside profits. Power company stock prices lost because of downside risk. Also, low betas of gas companies are consistent with our inference.

4.1.4 Subsidiaries of power companies

Most power companies have listed plant construction subsidiaries. Neither subsidiaries nor customer-supplier contracts between a power company and its subsidiaries are regulated, however. Interestingly, YURTEC, the listed plant construction subsidiary of TOHOKU ELEC. POWER gained 34.4% significantly at the 1% level, while the parent company lost 16%. In the second week after the accident and six subsidiary stock prices rose significantly at the 1% level or 5% level out of nine subsidiaries. The abnormal returns range from 7% to 25.1%. In the third week, the subsidiary stock prices dropped somewhat but only KANDENKO, a TEPCO's listed subsidiary last week gained 7.6% but lost 6.6% with significance at the 5% level. And it continued to decline by 7.2% in the forth week when most subsidiary stock prices dropped and eight subsidiaries abnormal returns range from -2% to 7.2%, as power company stock price declining sharply. Generally, subsidiary stock prices are not influenced by the act. Except two TEPCO's subsidiaries, the sums of abnormal returns for all periods are positive and range from 4% to 36%. The ownership levels of power companies range from 21.3% to 51.1% and most subsidiaries' top managers are former executives of parent power companies. It is interesting that a subsidiary stock price rises while the parent stock price losing. This is different from normal customer-supplier relationship (literature). For example, tunnel theory. These results might suggest that power companies are able to transfer wealth to subsidiaries to bypass regulation on power rates. Our results might raise an issue how to look into power company relationship with subsidiaries from the view point of consumers' welfare.

4.2 Cross-sectional analysis

In order to examine the relationship between abnormal returns and business compositions of energy companies, we conduct cross-sectional regressions using the weekly abnormal returns, the sum of weekly abnormal returns for four weeks after March 11 and the weekly abnormal returns around each bailout policy announcement. We obtained the data used in the cross sectional regressions from the most recent annual financial data available prior to the accident (e.g. March 2010 for firms whose accounting period ends in every March).

We include the percentage of nuclear energy generating capacity (*GENCAPN*) to measure the effect of the nuclear power plants on power companies. It is equal to zero if the firm is not a power company. *GENCAPN* reflects the exposure to nuclear risk of a power company. We expect power companies with higher *GENCAPN* are more adversely affected by the Fukushima accident. Since the Fukushima accident deeply harmed TEPCO, we include a dummy variable which is equal to 1 if the firm is TEPCO, and equal to 0 otherwise (*DTEPCO*) in order to control the specific effects of TEPCO. We expect negative (positive) coefficient on this dummy variable because TEPCO was seriously damaged by the accident (the bailout act).

The Fukushima accident also seriously damaged nuclear business firms, but their damages may be different from the power companies. We include the proportion of nuclear business in total sales (*PSNB*) to examine the effect for nuclear business firms. While the Fukushima accident damaged electricity firms and nuclear business firms, gas and alternative energy firms may get greater chance to expand their business to substitute nuclear energy. We include the sales proportion of gas business (*PSGAS*) and the sales proportion of alternative energy (*PSAE*).

We report cross-sectional regression results in Table 3. All models have strong explanatory power seen from R^2 of 34-79%. The all F-statistics show a rejection of the joint hypotheses that all explanatory variables are equal to zero. In the first week, TEPCO's stock price lost 42.3% and again it lost 36.0% in the third week after the accident for direct damage of its nuclear plants in Fukushima. The coefficient on *DTEPCO* is significant at the 1% level respectively. The adverse effect of exposure to nuclear energy on stock prices is not only statistically significant but also economically significant. The coefficient is -1.02 for three weeks after the accident. But the estimated coefficients rage from -0.0015 to -0.0032 in Lopatta1 and Kaspereit (2012), which is the closest to our study. More importantly, we find strong positive effect of alternative energy on stock prices after the accident. A 100% alternative energy gained 50% with statistical significance at the 1% level during the three weeks after the accident, as the estimated coefficient on *PSAE* indicate. In contrast, Lopatta1 and Kaspereit (2012) find evidence that a firm's composition of renewable energies did not contribute to stock price. They conclude that conventional energies were the main beneficiaries of the anticipated regulatory shift in energy policies. Our results lead to the conclusion that alternative energies might the main beneficiaries of the accident. Consistent with our inference that the market doubted regulated gas companies were motivated to compete with power companies and that it is less likely for regulated gas companies' shareholders to enjoy upside profits, gas business composition does not have a significant coefficient.

Cross-sectional regression results for bailout announcements are showed in Table 4. The Act on Institution Supporting Compensation for Nuclear Damages must be good news for TEPCO as indicated by the significant and positive coefficient on *DTEPCO*. But it is unclear for other power companies. However, the coefficient on *GENCAPN* is significantly positive and this suggests that a power company depends on more nuclear energy has a higher abnormal return for the week when the bill is adopted by the Cabinet. We find no significant relationship between the abnormal returns and other explanatory variables (*PSNB, PSGAS, PSAE*). The revised bill is less favored for power companies, since it mentioned the responsibility of stakeholders in case of nuclear accident. For revised bill event, the coefficient on *DTEPCO* is -0.091 with significance at the 5% level. Also, the coefficient on *GENCAPN* is -0.225 and it is significant at the 1% level. Totally, other power companies did not gained much from the Act on Institution Supporting Compensation for Nuclear Damages. The passage of the act revealed no information to the market, probably because it was anticipated.

Overall, these results support our hypothesis that direct damage of nuclear plants, the percentage of nuclear energy generating capacity, the sales proportion of nuclear business, the sales proportion of alternative energies are important to explain the abnormal returns during the Fukushima accident. Additionally, the results suggest the regulated gas business is not significantly affected by the accident.

5. Conclusion

In this paper, we investigate the reaction of energy stock prices to the accidents and to the government responses. We examine both the market reaction soon after the accidents, and the period thereafter when the Institution Supporting Compensation for Nuclear Damages Act was passed and signed into law. TEPCO's stock price lost the largest for direct damage of its nuclear plants in Fukushima. Also nuclear business stock prices drooped. We find that the more a power company depends on nuclear energy, its stock price dropped more after the accident. In contrast, alternative energy stock prices gained from the accident. The abnormal returns depend on business compositions of energy stocks and nuclear business stocks. We find that the market believes the primary beneficiary of the Act was TEPCO but other power companies did not gained much.

References

Barrett, W. B., Heuson, A. J., & Kolb, R. W. (1986). The effect of the Three Mile Island on utility bond risk premia: A note. Journal of Finance , 41 (1), pp. 225-261.

Betzer, A., Doumet, M., & Rinne, U. (2011, July). How policy changes affect shareholder wealth: The case of the Fukushima Daiichi nuclear disaster. University of Wuppertal : http://elpub.bib.uni-wuppertal.de/servlets/DerivateServlet/Derivate1932/sdp11011.pdf

Binder, J. J. (1985a). On the use of the multivariate regression model in event studies. Journal of Accounting Research, 23, 370–383.

Binder, J. J. (1985b). Measuring the effects of regulation with stock price data. Rand Journal of Economics, 16, 167–183.

Bowen, R. M., Castanias, R. P., & Daley, L. A. (1983). Intra-industry effects of the accident at the Three Mile Island. Journal of Financial and Quantitative Analysis , 16 (1), pp. 87-111.

Chandy, P. R., & Karafiath, I. (1989). The effect of the WPPSS crisis on utility common stock returns. Journal of Business Finance and Accounting , 16 (4), pp. 531-542.

Chen, C. R. (1984). The structural stability of the market model after the Three Mile Island Accident. Journal of Economics and Business , 36 (1), pp. 133-140.

Fama, E., Fisher, L., Jensen, M. C., & Roll, R. W. (1969). The adjustment of stock prices to new information. International Economic Review, 10 (1), pp. 1-21.

Ferstl, R., Utz, S., & Wimmer, M. (2012). The effect of the Japan 2011 disaster on nuclear and alternative energy stocks worldwide - An event study. Retrieved February 5, 2012, Electronic copy available at: http://ssrn.com/abstract=1842544

Fields, M. A., & Janjigian, V. (1989). The effect of Chernobyl on electric-utility stock prices. Journal of Business Research, 18 (1), pp. 81-87.

Gibbons, M. R. (1980). Econometric methods for testing a class of financial models—An application of the nonlinear multivariate regression model. Ph.D. dissertation, University of

Chicago.

Hill, J., & Schneeweis, T. (1983). The effect of the Three Mile Island on electric utility stock prices: A note. Journal of Finance , 38 (4), pp. 1285-1292.

Kalra, R., Henderson, G. V., & Raines, G. A. (1993). Effects of the Chernobyl nuclear accident on utility share prices. Quarterly Journal of Business and Economics , 32 (2), pp. 52-77.

Kerstin Lopatta and Thomas Kaspereit (2012). The Effects of the Fukushima Daiichi Nuclear Accident on Stock Prices of Firms with Nuclear, Renewable and Conventional Energy Production, Electronic copy available at: http://ssrn.com/abstract=1993016

Malatesta, P. (1986). Measuring abnormal performance: The event parameter approach using joint generalized least squares. Journal of Financial and Quantitative Analysis, 21, 465–477.

Mama, H. B., & Bassen, A. (2011). Contagion effects in the electric utility industry following the Fukushima nuclear accident. Retrieved December 23, 2011, from http://www.sirp.se/getfile.ashx?cid=280784&cc=3&refid=71

Hatsuru Morita (2012). Rescuing Victims and Rescuing TEPCO: A Legal and Political Analysis of the TEPCO Bailout. Tohoku University Discussion Paper

Pruitt, S. W., Tawarangkoon, W., & Wei, J. K. (1987). Chernobyl, commodities, and chaos: An examination of the reaction of commodity futures prices to evolving information. Journal of Futures Markets , 7 (5), pp. 555-569.

Shipper, K., & Thompson, R. (1983). The impact of merger-related regulations on the shareholders of acquiring firms. Journal of Accounting Research, 21, 184–221.

Spudeck, R. E., & Moyer, R. C. (1989). A note on the stock market's reaction to the accident at Three Mile Island. Journal of Economics and Business, 41 (3), pp. 235-240.

Uselton, G. C., Kolari, J. W., & Fraser, D. R. (1986). Long-term trends in the riskiness of electric utility shares. Journal of Business Finance and Accounting , 13 (3), pp. 453-459.

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. Journal of the American Statistical Association, 57, 348–368

Table 1 Descriptive statistics

	Mean	Std	Minimum	Maximum
GENCAPNP	0.053401	0.10315	0	0.30338
ECSHR	7.872	14.87609	0	46.68
PSNB	0.028158	0.091322	0	0.41
PSGAS	0.13626	0.29274	0	0.903
PSAE	0.088447	0.23674	0	0.96
DTODEN	0.026316	0.16222	0	1
Market Value of Equity	3.94593D+11	6.86677D+11	7.11070D+08	3.39723D+12
Ln(Market Value of Equity)	25.18149	1.99613	20.38228	28.85398
BETA	0.54834	0.39435	0.117	1.517
PBR	1.05799	0.68885	0.2972	3.6871
Leverage	2.47908	3.96224	0.237	25.277
ROA	0.036345	0.028384	-0.0389	0.1222

Table 2 Stock price response to the Fukushima nuclear accident and the government solution

	t1		t2		t3		t4		policy1	
Panel A: power companies										
TOKYO ELECTRIC POWER	-0.47	(4.92)**	-0.11	(1.37)	-0.454	(5.83)**	-0.037	(0.48)	0.619	(7.93)**
CHUBU ELECTRIC POWER	-0.043	(0.92)	-0.01	(0.25)	-0.08	(2.11)*	0.047	(1.22)	0.171	(4.49)**
KANSAI ELECTRIC POWER	-0.033	(0.74)	-0.012	(0.33)	-0.086	(2.40)*	0.028	(0.79)	0.129	(3.58)**
CHUGOKU ELECTRIC POWER	-0.006	(0.16)	-0.012	(0.35)	-0.082	(2.57)*	0.009	(0.28)	0.149	(4.64)**
HOKURIKU ELECTRIC POWER	-0.002	(0.06)	-0.021	(0.58)	-0.082	(2.36)*	-0.006	(0.19)	0.085	(2.43)*
TOHOKU ELECTRIC POWER	-0.16	(3.40)**	0.014	(0.36)	-0.089	(2.32)*	0.011	(0.29)	0.215	(5.61)**
SHIKOKU ELECTRIC POWER	-0.01	(0.25)	-0.016	(0.48)	-0.091	(2.77)**	0.005	(0.15)	0.075	(2.31)*
KYUSHU ELECTRIC POWER	-0.034	(0.84)	0.003	(0.08)	-0.094	(2.87)**	0.039	(1.18)	0.134	(4.06)**
HOKKAIDO ELECTRIC POWER	-0.044	(1.09)	0.007	(0.21)	-0.074	(2.25)*	-0.005	(0.15)	0.078	(2.34)*
OKINAWA ELECTRIC POWER	-0.053	(1.82)	0.009	(0.36)	-0.027	(1.13)	0.038	(1.57)	0.087	(3.63)**
Panel B: whole power companies										
ELECTRIC POWER DEVELOPMENT	-0.006	(0.15)	-0.004	(0.12)	-0.036	(1.08)	-0.034	(1.03)	0.073	(2.19)*
Panel C: nuclear business companies										
TOKYO ENERGY & SYSTE	-0.097	(1.93)	0.138	(3.24)**	-0.065	(1.59)	-0.039	(0.95)	0.043	(1.04)
SHIN NIPPON AIR TEC.	-0.161	(5.22)**	0.188	(7.26)**	-0.025	(0.98)	-0.104	(4.12)**	0.012	(0.47)
TOSHIBA PLANT SYSTEM	-0.057	(1.28)	-0.001	(0.03)	0.013	(0.36)	-0.095	(2.64)**	0.019	(0.54)
KIMURA CHEM. PLANT	-0.103	(2.12)*	0.018	(0.43)	0.01	(0.25)	-0.009	(0.22)	0.02	(0.51)
Panel D: alternative energy stocks										
JAPAN WIND DEVELOPME	0.262	(1.41)	0.528	(3.38)**	-0.081	(0.53)	-0.015	(0.10)	-0.078	(0.52)
FUJIPREAM	-0.016	(0.15)	0.205	(2.31)*	-0.023	(0.27)	0	0.00	0.272	(3.14)**
FIRST ENERGY SERVICE	0.141	(1.16)	0.343	(3.38)**	0.215	(2.18)*	1.169	(11.88)**	0.245	(2.49)*
WEST HOLDINGS	0.033	(0.29)	0.206	(2.17)*	0.265	(2.88)**	-0.032	(0.35)	0.062	(0.67)
FERROTEC	0.125	(1.69)	0.107	(1.72)	0.083	(1.38)	0.008	(0.14)	0.003	(0.05)
NPC	0.3	(3.62)**	-0.022	(0.32)	-0.035	(0.52)	0.016	(0.23)	-0.002	(0.04)
KOBE STEEL	0.178	(6.13)**	0.006	(0.24)	0.038	(1.61)	-0.023	(0.98)	0.039	(1.64)
	t1		t2		t3		t4		policy1	
Panel E: gas companies										
TOKYO GAS	0.009	(0.34)	0.024	(1.14)	0.036	(1.73)	0.008	(0.37)	0.033	(1.62)
OSAKA GAS	-0.001	(0.05)	0.023	(1.18)	0.029	(1.50)	-0.009	(0.49)	0.017	(0.87)
TOHO GAS	-0.063	(1.73)	0.046	(1.51)	-0.006	(0.21)	-0.011	(0.37)	0.037	(1.25)
HOKKAIDO GAS	-0.012	(0.42)	0.04	(1.67)	0.003	(0.13)	-0.005	(0.23)	-0.012	(0.52)
SAIBU GAS	0.038	(1.57)	-0.007	(0.34)	-0.036	(1.83)	-0.015	(0.77)	0.024	(1.18)
HOKURIKU GAS	-0.013	(0.76)	0.035	(2.37)*	-0.023	(1.62)	-0.019	(1.37)	0.004	(0.29)
SHIZUOKAGAS	-0.031	(0.70)	0.195	(5.18)**	-0.028	(0.77)	0.015	(0.41)	0.009	(0.25)
Panel F: power company subsidiaries										
KANDENKO	0.028	(0.78)	0.076	(2.52)*	-0.066	(2.25)*	-0.072	(2.45)*	0.046	(1.56)
TAKAOKA ELECTRIC MFG	0.039	(0.63)	-0.051	(0.98)	-0.009	(0.18)	0.009	(0.17)	0.058	(1.16)
KANTO NATURAL GAS	0.053	(2.58)*	0.246	(14.36)**	-0.01	(0.58)	-0.032	(1.93)	0.018	(1.10)
YURTEC	0.344	(6.91)**	0.057	(1.35)	-0.02	(0.50)	-0.05	(1.24)	0.07	(1.71)
KYUDENKO	-0.062	(1.67)	0.158	(5.11)**	0.02	(0.67)	-0.066	(2.18)*	0.008	(0.28)
YONDENKO	-0.007	(0.20)	0.086	(2.99)**	0.022	(0.80)	-0.06	(2.15)*	-0.008	(0.28)
HOKURIKU ELEC. CONST	0.04	(1.19)	0.251	(8.85)**	-0.005	(0.18)	-0.036	(1.32)	0.011	(0.39)
CHUDENKO	0.071	(2.00)*	0.073	(2.44)*	-0.031	(1.09)	-0.02	(0.70)	-0.042	(1.46)
KINDEN	0.009	(0.31)	0.07	(2.83)**	0.009	(0.39)	-0.02	(0.82)	-0.022	(0.93)
Joint test for all firms										
H2 t1=t2=t3=t4=lolicy1=policy2=policy3=0	14.158115 ***		15.257702 ***		4.1763731 ***		16.893227 ***		9.6106071 ***	
H3 t1=t2=t3=t4=lolicy1=policy2=policy3	14.539674 ***		13.212448 ***		4.2465084 ***		17.211764 ***		9.5311406 ***	

Table 2 (continued)

policy2		policy3		Constant		a1		b		b1		Observations	R-squared
-0.176	(2.21)*	0.017	(0.21)	-0.002	(0.20)	-0.018	(1.09)	0.263	(0.59)	0.415	(0.55)	103	0.63
-0.075	(1.93)	-0.004	(0.10)	-0.001	(0.18)	-0.006	(0.71)	0.192	(0.88)	0.011	(0.03)	103	0.28
-0.081	(2.19)*	-0.02	(0.53)	0	(0.03)	-0.01	(1.29)	0.146	(0.71)	0.032	(0.09)	103	0.25
-0.08	(2.46)*	-0.013	(0.38)	-0.001	(0.17)	-0.001	(0.20)	0.255	(1.39)	0.068	(0.22)	103	0.31
-0.085	(2.39)*	-0.011	(0.29)	0	(0.02)	-0.003	(0.39)	0.288	(1.45)	-0.07	(0.21)	103	0.2
-0.063	(1.61)	-0.003	(0.07)	0	(0.01)	-0.016	(1.98)	0.282	(1.29)	0.082	(0.22)	103	0.46
-0.083	(2.50)*	0.004	(0.13)	0	(0.05)	0.002	(0.28)	0.136	(0.73)	0.098	(0.31)	103	0.2
-0.08	(2.37)*	-0.009	(0.27)	-0.001	(0.13)	-0.008	(1.19)	0.172	(0.91)	0.102	(0.32)	103	0.31
-0.086	(2.53)*	-0.041	(1.17)	0	(0.09)	-0.007	(1.00)	0.117	(0.62)	-0.229	(0.72)	103	0.2
-0.056	(2.26)*	0.005	(0.22)	-0.003	(1.13)	-0.001	(0.11)	0.258	(1.88)	-0.166	(0.71)	103	0.27
-0.095	(2.78)**	-0.018	(0.50)	-0.001	(0.18)	-0.002	(0.31)	0.171	(0.90)	-0.48	(1.49)	103	0.16
-0.044	(1.05)	-0.015	(0.34)	0	(0.03)	-0.004	(0.44)	0.811	(3.44)**	-0.514	(1.29)	103	0.32
-0.035	(1.35)	-0.024	(0.91)	-0.004	(1.32)	0.01	(1.87)	0.74	(5.14)**	-0.272	(1.12)	103	0.68
-0.012	(0.33)	-0.004	(0.10)	-0.001	(0.14)	0.003	(0.46)	0.803	(3.89)**	0.308	(0.88)	103	0.41
-0.055	(1.35)	-0.006	(0.15)	-0.005	(0.94)	0.001	(0.14)	1.517	(6.67)**	-0.162	(0.42)	103	0.54
-0.083	(0.54)	-0.011	(0.07)	-0.018	(0.94)	0.041	(1.29)	0.279	(0.32)	1.133	(0.77)	103	0.19
-0.057	(0.64)	-0.021	(0.23)	0	(0.02)	0	(0.02)	0.605	(1.23)	0.774	(0.93)	103	0.24
-0.139	(1.38)	-0.078	(0.75)	-0.004	(0.34)	-0.002	(0.12)	0.903	(1.60)	-0.525	(0.55)	103	0.65
-0.074	(0.78)	-0.078	(0.79)	-0.008	(0.73)	0.025	(1.28)	1.148	(2.17)*	0.03	(0.03)	103	0.25
0.001	(0.02)	0.07	(1.10)	0.007	(0.98)	-0.023	(1.79)	1.087	(3.14)**	0.67	(1.15)	103	0.3
-0.126	(1.82)	-0.054	(0.76)	-0.006	(0.73)	-0.006	(0.43)	0.625	(1.61)	0.791	(1.21)	103	0.23
0.029	(1.21)	0.044	(1.75)	0.003	(0.95)	-0.011	(2.24)*	1.408	(10.38)**	0.684	(2.98)**	103	0.75
policy2		policy3		Constant		a1		b		b1		Observations	R-squared
-0.008	(0.38)	-0.03	(1.39)	-0.001	(0.27)	0	(0.01)	0.178	(1.51)	-0.031	(0.16)	103	0.14
-0.02	(1.00)	-0.033	(1.64)	-0.001	(0.35)	0.001	(0.21)	0.299	(2.72)**	-0.312	(1.68)	103	0.15
-0.066	(2.17)*	-0.031	(0.98)	-0.003	(0.78)	0.008	(1.35)	0.334	(1.96)	-0.617	(2.14)*	103	0.15
0.007	(0.29)	-0.026	(1.07)	0	(0.01)	0.004	(0.78)	0.205	(1.56)	0.018	(0.08)	103	0.13
0	(0.02)	-0.023	(1.09)	-0.003	(1.23)	0.007	(1.60)	0.28	(2.45)*	0.426	(2.21)*	103	0.32
0.008	(0.55)	0.003	(0.17)	-0.001	(0.42)	0	(0.03)	0.259	(3.18)**	-0.024	(0.17)	103	0.28
0.048	(1.29)	0.046	(1.19)	-0.004	(0.85)	0.003	(0.42)	0.258	(1.23)	0.306	(0.87)	103	0.34
-0.011	(0.35)	0.045	(1.43)	-0.003	(0.88)	0.003	(0.56)	0.749	(4.44)**	0.593	(2.08)*	103	0.52
-0.008	(0.15)	0.034	(0.64)	0.007	(1.18)	-0.018	(1.73)	1.377	(4.78)**	0.941	(1.93)	103	0.47
0.028	(1.67)	-0.028	(1.56)	-0.001	(0.58)	-0.004	(1.25)	0.655	(6.88)**	0.068	(0.42)	103	0.8
-0.067	(1.61)	-0.041	(0.96)	-0.004	(0.85)	0.003	(0.30)	0.628	(2.70)**	-0.155	(0.39)	103	0.47
-0.015	(0.49)	-0.101	(3.17)**	-0.002	(0.60)	0.008	(1.25)	0.93	(5.41)**	-0.262	(0.90)	103	0.57
-0.013	(0.46)	-0.022	(0.74)	-0.005	(1.39)	0.009	(1.48)	0.53	(3.32)**	0.237	(0.88)	103	0.4
0.001	(0.02)	0.055	(1.88)	-0.001	(0.42)	-0.005	(0.81)	0.291	(1.85)	0.355	(1.34)	103	0.56
0.01	(0.33)	-0.045	(1.46)	-0.003	(0.71)	0.002	(0.27)	0.906	(5.48)**	-0.318	(1.14)	103	0.39
-0.029	(1.18)	0.003	(0.12)	-0.002	(0.72)	0.003	(0.65)	0.752	(5.50)**	-0.028	(0.12)	103	0.46
2.0667816 ***		2.0895851 ***											
2.106736 ***		2.1085059 ***											

Table 3 Cross sectional regressions for accident event

	Dep Var=t1		Dep Var=t2		Dep Var=t3		Dep Var=t1+t2+t3	
	coefficient	t value	coefficient	t value	coefficient	t value	coefficient	t value
C	0.031	1.41	0.089	3.16	-0.002	-0.09	0.12	3.23
GENCAPNP	-0.293	-1.86	-0.387	-1.92	-0.343	-2.81	-1.02	-3.90
PSNB	-0.395	-2.45	-0.023	-0.11	-0.067	-0.53	-0.48	-1.80
PSGAS	-0.058	-1.12	-0.043	-0.65	-0.004	-0.11	-0.11	-1.22
PSAE	0.221	3.50	0.189	2.34	0.088	1.80	0.50	4.74
DTEPCO	-0.423	-4.63	-0.095	-0.81	-0.360	-5.08	-0.88	-5.77
R^2	0.66		0.34		0.65		0.79	
F-statistic	12.43		3.25		11.90		23.64	

Table 4 Cross sectional regressions for policy event

	Dep Var=policy1		Dep Var=policy2		Dep Var=policy3	
	coefficient	t value	coefficient	t value	coefficient	t value
C	0.058	3.11	-0.025	-2.84	-0.006	-0.66
GENCAPNP	0.254	1.90	-0.225	-3.55	-0.028	-0.40
PSNB	-0.098	-0.71	-0.028	-0.43	-0.016	-0.22
PSGAS	-0.056	-1.27	0.029	1.37	-0.006	-0.28
PSAE	-0.037	-0.70	-0.091	-3.59	-0.044	-1.57
DTEPCO	0.493	6.34	-0.091	-2.46	0.031	0.77
R^2	0.68		0.59		0.09	
F-statistic	13.72		9.26		0.63	