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C O L U M B I A   U N I V E R S I T Y   I N   T H E   C I T Y   O F   N E W   Y O R K

# Evaluating the Economic Response to Japan's Earthquake

Molly K. Schnell and David Weinstein

## **Abstract**

This paper compares the 1995 Kobe earthquake with the more recent one in Tohoku. The impact of the recent earthquake on industrial production was much larger and long-lasting than that of the 1995 earthquake. We find that very little of this can be explained by differences in government expenditures or private consumption. However, we find very substantial differences in energy production in the wake of the two earthquakes. The substantial and persistent drop in energy output is likely to have exacerbated supply disruptions and may continue to slow the pace of recovery. Moreover, we provide some evidence that Japan's increasing reliance on fossil fuel sources of energy is likely to result in a large number of deaths and increases in morbidity due to increased air pollution. These results highlight the difficulties that Japan is likely to face in its move away from nuclear power.

# Evaluating the Economic Response to Japan's Earthquake

Molly K. Schnell and David E. Weinstein

February 9, 2012

On March 11, 2011 at 14:46 Tokyo time, an earthquake of magnitude 9.0 occurred off the coast of Japan in the western Pacific. The quake triggered a massive tsunami that reached the eastern coast of Japan within minutes. The effects of the dual-tragedy were immediate: 19,996 people lost their lives, 275,258 homes were destroyed, and another 580,559 houses were damaged.

Nearly a year after the tragedy, Japan is still working to reorganize, rebuild, and reassert itself as an international power. This paper outlines the economic effects of the Tohoku earthquake and tsunami and presents steps that Japan must take to move forward. A comparison with the 1995 Kobe earthquake suggests that policy decisions to reduce reliance on nuclear energy in the short run are hampering Japan's recovery. The reopening of reactors at the Takahama, Kashiwazaki Kariwa, and Tomari plants is promising both in terms of economic recovery and long-term health outcomes. A move from nuclear power to fossil fuels would likely result in far more fatalities than those arising from radiation.

Japan has the unfortunate distinction of being a country that has suffered a disproportionate number of catastrophic events. Not only is Japan prone to earthquakes and other natural disasters, but many Japanese cities were devastated by bombings during World War II. Davis and Weinstein (2002) analyze the impacts of these events and provide some relatively optimistic news for the affected regions: populations and industries tend to recover in the wake of these catastrophic events. While we hope that the impact of the current earthquake is comparable, in this paper we examine to what extent policy decisions have affected the trajectory of recovery from the recent disaster.

Over the last 100 years, there have been nine earthquakes in Japan that have killed over 1,000 people (USG, 2011). Of these, the 1995 Kobe earthquake and the recent Tohoku disaster were two of the worst three events in terms of casualties. To examine the success, speed, and lasting implications of the recovery, we compare the 1995 and 2011 disasters from a policy standpoint.

# 1 Kobe and Tohoku Compared

Figure 1: Comparison of Magnitude: 1995 vs. 2011 Disasters

	Kobe	Tohoku
Dead and Missing	6,400	19,996
Partial/Total Collapsed Homes	240,956	275,258
Damaged Homes	NA	580,559
GDP Share of Impact Area (Narrow)	4%	4%
GDP Share of Impact Area (Broad)	11%	6%
Total Cost	Y9,900 bil	NA
Gov't Reconstruction Exp	Y5,020 bil	Y12,100 bil

Source: Government of Japan

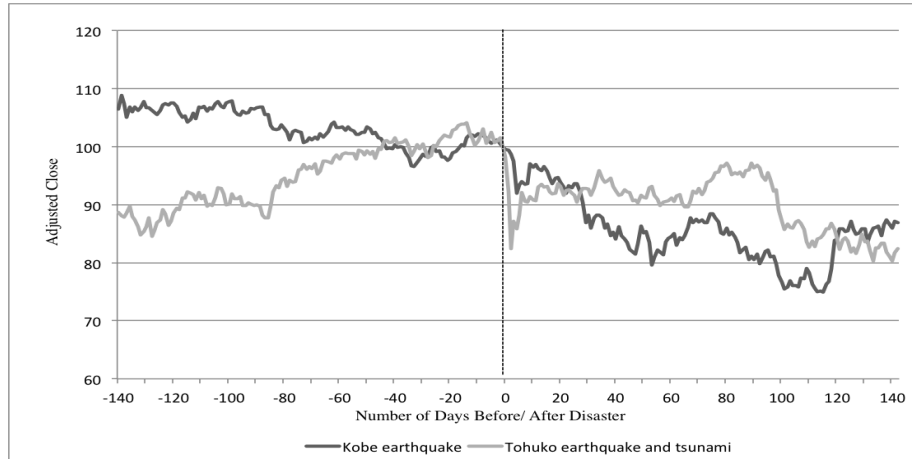
Figure 1 provides basic statistics for both earthquakes. As one can see from the figure, the 2011 dual-disaster resulted in three times as many casualties as the 1995 earthquake. However, the results from Davis and Weinstein (2002) suggest that the destruction of capital stock is a better metric than lives lost for understanding the economic impact of a catastrophic event. In the case of the 2011 Tohoku earthquake and tsunami, the Japanese Cabinet Office estimated that the damage to physical capital amounted to 1% of the total national stock. Similarly, the Kobe earthquake's damage to physical capital amounted to 0.8% of the total national stock at the time (Drysdale, 2011). Moreover, the fact that the number of collapsed homes was comparable to the 1995 earthquake suggests that the two events were comparable in this dimension. The events are also not very different if one compares the share of GDP that was produced in the prefecture most affected by the earthquake or the prefectures with substantial damage.

Market reactions tell a somewhat similar tale. As one can see from Figure 2,<sup>1</sup> the market reactions to the two events were comparable. Stocks were down 4.3% three weeks after the Kobe earthquake as compared to 6.9% after Tohoku. For both events, the decline was more pronounced over the course of the next few weeks.

Differences between the disasters start to emerge when we turn our attention

<sup>1</sup>In Figure 2 and in subsequent figures, we rescale the data such that "Day 0," "Month 0," and "Quarter 0" correspond to the day, month, and quarter of the earthquake, respectively. For the Kobe earthquake, "Day 0" is January 17, 1995; "Month 0" is January, 1995; and "Quarter 0" is Q1 1995. For the Tohoku disaster, "Day 0" is March 11, 2011 and "Month 0" is March, 2011. Since the recent disaster hit at the end of Q1 2011, we denote Q2 2011 as "Quarter 0."

Figure 2: Comparison of Effect on Nikkei 225: 1995 vs. 2011 Disasters



Source: Yahoo! Finance

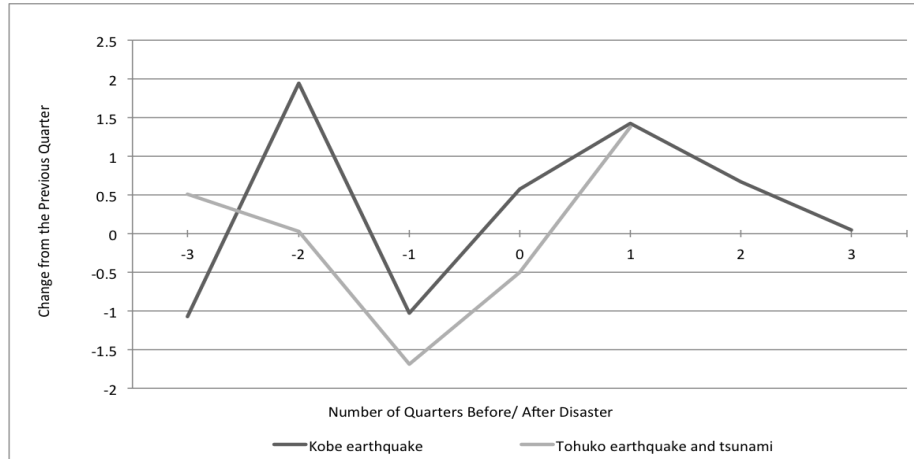
Notes: The Nikkei 225 is to 100 on the day before the disaster, and day-to-day percent changes are used to adjust the index on the other days accordingly.

to growth rates. In the quarter leading up to each earthquake, growth was similar with quarterly growth rates of -1.03% and -1.69%, respectively. However, looking to Figure 3, we see that growth was 1 percentage point higher in the quarter following the Kobe earthquake than it was in the quarter following the Tohoku disaster. While both earthquakes occurred during cyclical downturns, the recovery was faster after the 1995 disaster. In the quarter following the Kobe earthquake, GDP rose by 0.58% as compared with -0.50% – a gap of 1.08%.

Further highlighting the slower recovery, Figure 4 compares industrial production after each disaster. While it is apparent from this figure that the Industrial Production Index fell more sharply following the Tohoku disaster, it is also clear that industrial production has recovered more slowly. While industrial production had returned to pre-quake levels within a month and a half of the Kobe earthquake, industrial production was still only 96% of pre-quake production nine months after the Tohoku disaster. Furthermore, the initial sharp upward trend leveled off, suggesting that the general level of industrial production will be lower for some time.

These differences in the rates of recovery bring about an important question with substantial policy implications: What explains the slow recovery? Think-

Figure 3: Comparison of Effect on GDP Growth: 1995 vs. 2011 Disasters

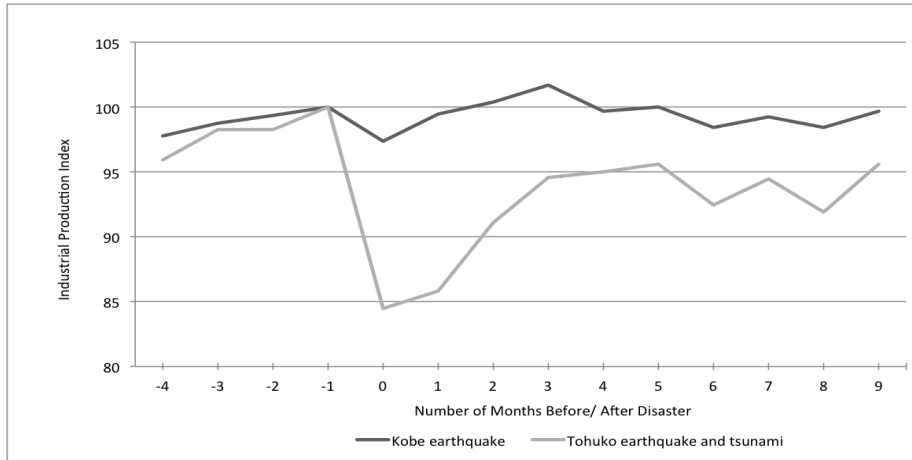


Source: OECD StatExtracts

ing in simple economic terms, the slow recovery could either be the result of reduced demand, stagnating supply, or both.

**Demand** On the demand side, there are three potential suspects: slow government stimulus, low foreign demand due to yen appreciation, and cutback in domestic demand due to “self-restraint” in the wake of the crisis. As the next three figures indicate, none of these explanations seem likely. In Figure 5, we do see that government spending rose more sharply after the 1995 earthquake, but this difference in fiscal response only accounts for about 8% of the difference in GDP performance. Figure 6 demonstrates that despite the media attention given to reductions in spending following the Tohoku earthquake, consumption behavior was quite similar to what followed the Kobe earthquake. Therefore, the decrease in demand due to “self-restraint” is probably not important in understanding the differential recoveries. Lastly, in Figure 7, we see that appreciation of the yen was much steeper in 1995 than in 2011. While a stronger yen has arguably hurt Japan’s export-heavy economy, declining foreign demand is not to blame for the slower recovery after the recent disaster.

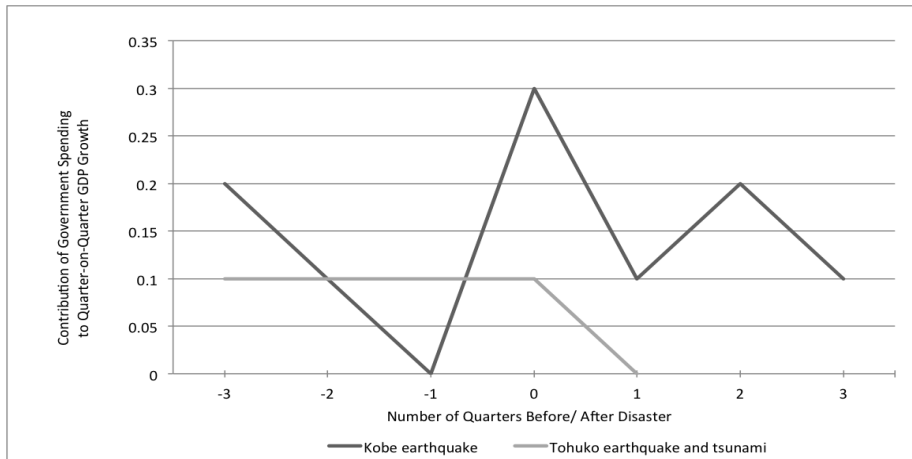
Figure 4: Comparison of Effect on Industrial Production: 1995 vs. 2011 Disasters



Source: METI

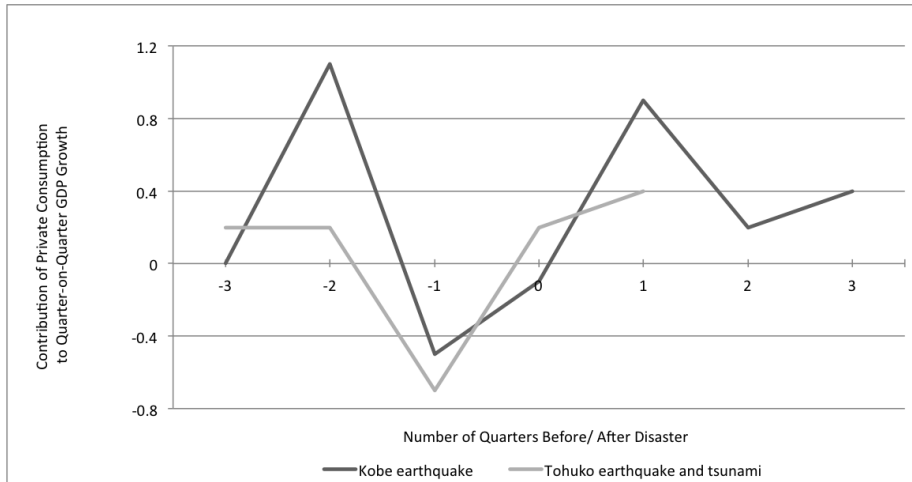
Notes: The Industrial Production Index is set to 100 in the month before the disaster, and month-to-month percent changes are used to adjust industrial production in the other months accordingly.

Figure 5: Comparison of Effect on Government Spending: 1995 vs. 2011 Disasters



Source: OECD Statistics

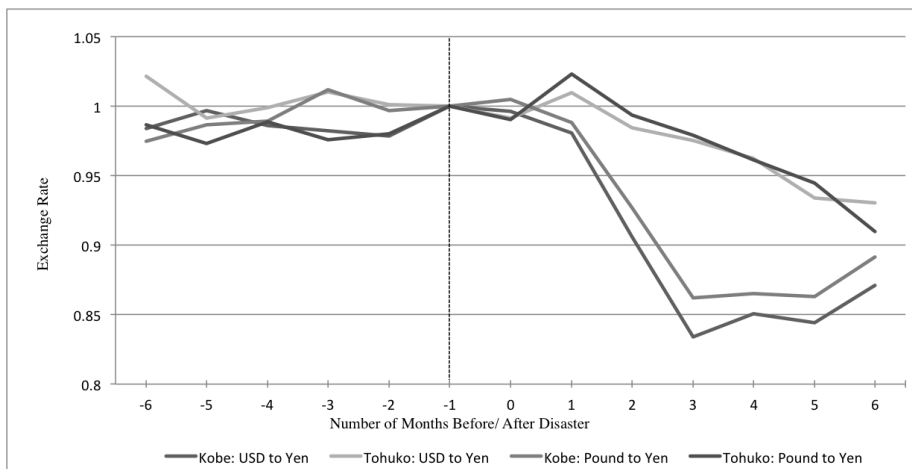
Figure 6: Comparison of Effect on Private Consumption: 1995 vs. 2011 Disasters



Source: OECD Statistics

Notes: Contributions to growth are seasonally adjusted.

Figure 7: Comparison of Effect on Exchange Rates: 1995 vs. 2011 Disasters



Source: Bank of Japan, Bank of England

Notes: Exchange rates are set to 1 in the month before the disaster, and month-to-month percent changes are used to adjust exchange rates in the other months accordingly.



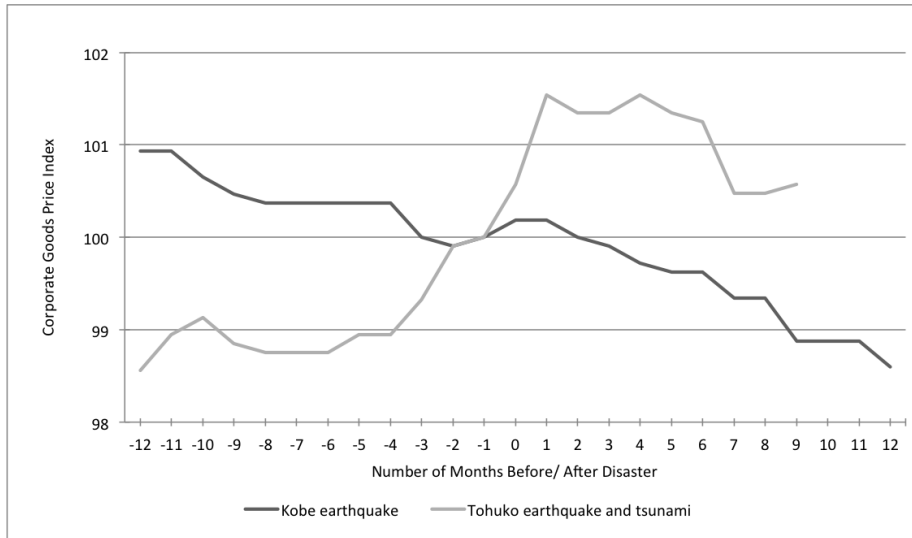
**Supply** Turning to the supply side, Figure 8 suggests that there has been a substantial decrease in supply. The rapid increase in the Corporate Goods Price Index coupled with falling output indicates a dramatic contraction in the supply of goods. What is to blame for this decrease in supply? Much attention has been given to the disruption of supply chains as a result of the disaster. Many upstream industries were located in the affected areas, and thus disruptions to local supply affected production across Japan. While this argument certainly holds in the short term, it is unlikely that supply chain disruptions are to blame for Japan's continued low output. Assuming some substitutability in the production of intermediate goods, one would expect to see much lower output levels in areas affected by the earthquake than in unaffected areas if supply chain disruptions were still the constraint. This is not the case: 83% of firms in unaffected areas and 80% of firms in affected areas were producing at or above pre-quake levels by June of 2011 (GoJ, 2011). The fact that production rebounded nearly uniformly across Japan suggests that there was a general supply shock that did not only affect the production of goods in areas directly affected by the disaster.

Figure 9 is the missing piece of the puzzle: energy production in Japan not only fell in the month of the disaster, but it continued to fall in the following months. Although only 11 nuclear power plants were directly affected by the earthquake and tsunami, communities around the country have refused to let reactors that were closed for routine maintenance to be restarted. As a result of this opposition, only 3 of the 54 nuclear reactors are currently functioning. It was not until last November, nearly seven months after the Fukushima disaster, that the first idled nuclear reactor was permitted to reopen. Given that nuclear power once provided nearly a quarter of Japan's electricity, the idled reactors are having widespread repercussions. Although Prime Minister Yoshihiko Noda is determined to restart all idled reactors by this summer, it is not clear whether or not he will be able to achieve this goal.

## 2 The Fukushima Nuclear Disaster

The combination of the spectacle of the nuclear disaster at Fukushima and the relatively unknown effects of exposure to nuclear radiation have led to widespread opposition to nuclear power. Once seen as a safe alternative to fossil fuels and the future of energy production, countries across the globe have

Figure 8: Comparison of Effect on Corporate Goods Price Index: 1995 vs. 2011 Disasters



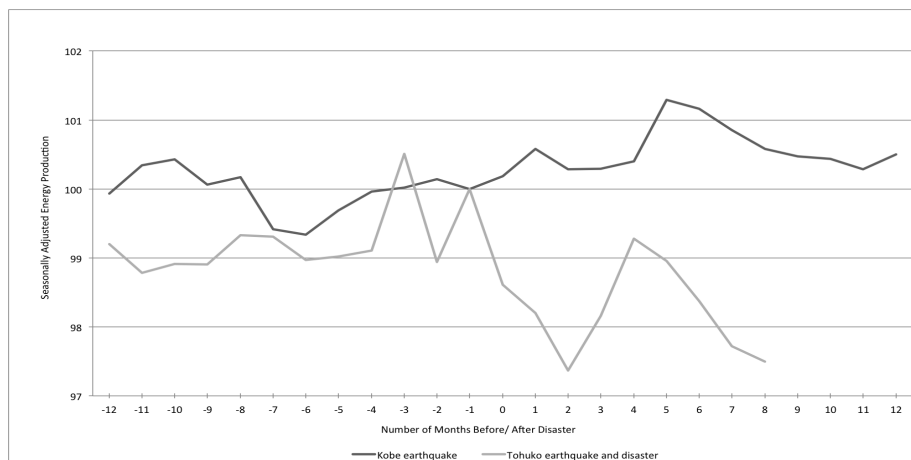
Source: Bank of Japan

Notes: The CGPI is set to 100 in the month before the disaster, and month-to-month percent changes are used to adjust the CPGI in the other months accordingly.

begun to turn-away from nuclear power. Following the Fukushima crisis, Germany said that it would close all of its nuclear power plants by 2022. In the United States, no new nuclear power plant has been built since the much smaller Three Mile Island event in 1979.

Is this retreat from nuclear power justified from a public health standpoint? Not necessarily. Estimates of the number of cancer deaths due to the release of radiation range from zero (Normile, 2011) to 1,000 (von Hippel, 2011). By contrast, the shift from nuclear energy to fossil fuel sources is likely to produce a large number of deaths due to the release of combustion byproducts. Figure 10 shows the number of deaths and cases of morbidity per terawatt hour derived from different energy sources. Despite the spectacular events at Chernobyl and Fukushima, nuclear power still appears to be a much safer alternative to fossil fuels. To put these numbers in perspective, Japan's nuclear power plants produced around 265.8 TWh of energy prior to the earthquake (Lavelle and Mulligan, 2011). If Japan were to replace these sources with coal-based plants, there would be approximately 15,241 deaths per year as a direct result of the

Figure 9: Comparison of Effect on Energy Production: 1995 vs. 2011 Disasters



Source: CEIC Data Manager

Notes: Figures are seasonally adjusted. Energy production is set to 100 in the month before the disaster, and month-to-month percent changes are used to adjust energy production in the other months accordingly.

shift. Similarly, a shift to oil-based energy sources would cause approximately 4,891 deaths per year. Pollutants from fossil fuels also cause a number of serious illnesses, such as congestive heart failure and chronic bronchitis. A move toward coal or oil sources would likely cause between 139,013 and 42,794 cases of such illnesses, respectively.

While dying from a nuclear catastrophe is more spectacular than dying slowly from consequences of air pollution, other forms of energy are not without their spectacles: the Iraq war, Japan's entry into World War II, the BP oil spill, not to mention global warming, are all events that can be tied to countries' reliance on fossil fuels. Although there is still a long way to go to make nuclear energy sufficiently safe, it is far from clear that other energy sources are less dangerous options.

### 3 Looking to the Future

This policy brief suggests that Japan is facing some difficult choices. The sudden move away from nuclear power is likely to have serious economic and health

Figure 10: Health Effects of Electricity Generation in Europe by Primary Energy Source (Deaths/Cases per TWh)

	Deaths from Accidents		Air Pollution-Related Deaths		
	Public	Occupational	Deaths*	Serious Illness**	Minor Illness***
Lignite	0.02	0.10	32.6	298	17,676
Coal	0.02	0.10	24.5	225	13,288
Gas	0.02	0.001	2.8	30	703
Oil	0.03	–	18.4	161	9,551
Biomass	–	–	4.63	43	2,276
Nuclear	0.003	0.019	0.052	0.22	–

Source: Markandya and Wilkinson (2007)

\* Includes acute and chronic effects. Chronic deaths are between 88% and 99% of total. For nuclear, power, they include all cancer-related deaths.

\*\* Includes respiratory and cerebrovascular hospital admissions, congestive heart failure, and chronic bronchitis. For nuclear power, they include all non-fatal cancers and hereditary effects.

\*\*\* Includes restricted activity days, bronchodilator use cases, cough, and lower-respiratory symptom days in patients with asthma, and chronic cough episodes.

implications for Japan. Such adverse effects are likely to compound the tragic events of March 11.

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