



Effect of the Fukushima nuclear disaster on global public acceptance of nuclear energy



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HIGHLIGHTS

- Fukushima accident has negatively changed public attitudes toward nuclear energy.
- Effect of operational experience became considerably negative after the accident.
- Effect of proportion of nuclear power generation is positive after the accident.
- Effect of government pressure on media content became negative after the accident.
- Country specific policy responses on nuclear public acceptance are required.

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ABSTRACT

The Fukushima nuclear disaster has significantly changed public attitudes toward nuclear energy. It is important to understand how this change has occurred in different countries before the global community revises existing nuclear policies. This study examines the effect of the Fukushima disaster on public acceptance of nuclear energy in 42 countries. We find that the operational experience of nuclear power generation which has significantly affected positive public opinion about nuclear energy became considerably negative after the disaster, suggesting fundamental changes in public acceptance regardless of the level of acceptance before the disaster. In addition, contrary to our expectation, the proportion of nuclear power generation is positively and significantly related to public acceptance of nuclear energy after the Fukushima accident and government pressure on media content led to a greater decrease in the level of public acceptance after the accident. Nuclear energy policymakers should consider the varied factors affecting public acceptance of nuclear energy in each country depending on its historical, environmental, and geographical circumstances before they revise nuclear policy in response to the Fukushima accident.

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1. Introduction

The Fukushima nuclear accident, which was caused by a huge tsunami after a magnitude 9 undersea earthquake in March 2011, was extraordinary in terms of its significant and extensive damage and its negative effect on local and global environments. According to the report of Japan Atomic Industrial Forum, around 15,000 terabecquerels of caesium-137 was released from reactor 1–3 at the Fukushima Dai-ichi nuclear power plant, 168.5 times that of the atomic bomb dropped on Hiroshima. Radioactive materials from the Fukushima accident, including iodine-131, caesium-134,

and caesium-137, were detected around the world, including in North America and Europe. High levels of radioactive isotopes were also released into the Pacific Ocean. People within a 20-km zone around the Fukushima Dai-ichi nuclear plant had to leave the area, with more than 80,000 people displaced (International Atomic Energy Agency (IAEA), 2011). The disaster was classified as a Level 7 nuclear accident, the highest level on the International Nuclear Event Scale, equal to that of the Chernobyl nuclear disaster.

The Fukushima accident has also had a significant effect on the nuclear policies of many countries. Many governments have changed or redirected their investments in nuclear energy, and the construction of various nuclear power plants has been suspended (Ramana, 2011). The Japanese government announced a comprehensive review of its energy policy and halted its plans to build additional nuclear reactors. Germany shut down all 17 of its

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operational nuclear power reactors, and Switzerland agreed to phase out its 5 aging power reactors as they reached the end of their lifecycles over the next 25 years. Italy decided to exclude nuclear energy from its future energy mix (Froggatt and Schneider, 2011). Even though the United States government appears determined to retain nuclear energy as part of its national energy mix, some officials have cautioned that the country must learn from the Fukushima nuclear accident (Ehreisler, 2011).

It is important for policymakers to understand how this nuclear disaster has changed public attitudes toward nuclear power in different countries before they revise existing nuclear policies. Thus, this study examines critical factors that affected public acceptance of nuclear energy by closely examining changes in public opinion in 42 countries after the Fukushima accident. By examining these changes, the sources of different policy reactions to the disaster in different countries can be understood and insights on future directions can be drawn. Our investigation considers the level of social acceptance of nuclear energy by using information about the level of dependence on nuclear energy, which includes operational experience in producing nuclear energy, of each country. Political pressure on the media is also considered, to investigate the extent to which it controls the informational bias of a country. The effect of a country's distance from the accident site is also considered.

Results from this empirical analysis will help us to understand in what way a historical disaster such as the Fukushima accident affects public acceptance of nuclear energy; considering these factors will enable governments to establish comprehensive and rational nuclear policies rather than ad-hoc and spontaneous responses. Additionally, the consideration of various country- and individual-level characteristics that might be related to changes in public acceptance of nuclear energy after the accident will suggest country-specific insights for revising nuclear energy policy.

2. Nuclear accidents and public acceptance of nuclear energy

A nuclear accident has both a direct and an indirect negative effect on public acceptance of nuclear energy. Its direct effect is the damage from the released radioactive materials. There is no spatial limit to the diffusion of radioactive materials in the air, and the half-life of radioactive isotopes is generally long. Therefore, every being on earth is affected by radioactive contamination (Fang et al., 1995; Ginzburg and Reis, 1991; Johnson et al., 2007).

The indirect effect of a nuclear accident is the stigma it creates. Stigma refers to a mark designed to expose something unusual and bad about the moral status of the person or group to which it applies (Goffman, 1963). Although nuclear accidents are rare, they produce severe damage and therefore generate a strong signal that there is an unusual risk in nuclear power generation (Slovic, 1987). This signal helps to perpetuate a negative image or stigmatization of nuclear energy (Gregory et al., 1995).

A serious nuclear accident, such as the one that occurred at Fukushima, appears to increase the negative effect of nuclear energy directly and indirectly. This is supported by previous studies that examined nuclear disasters such as those at Three Mile Island (Melber, 1982; Nealey et al., 1983; Rosa, 2001; Rosa and Dunlap, 1994) and Chernobyl (Renn, 1990; Rosa and Dunlap, 1994; Smith and Michaels, 1987). However, it is important to note that the effect of an accident on public acceptance can differ in different countries depending on factors, such as geography, history, and environment. Especially considering that nuclear disasters release radioactive contamination that affects broad geographical areas, it is important to understand the effect of distance on public acceptance of nuclear energy.

Depending on the distance from the accident site, public opinion may be affected by two contradictory effects: proximity and distance. The proximity effect involves an inverse relationship between distance from an accident site and the level of public acceptance. In other words, the closer an area is to the site of an accident, the lower public acceptance is for the source of the accident (Rosa and Dunlap, 1994). In the case of nuclear energy, this is because an area closer to the accident site has higher concentrations of radioactive materials and higher probabilities of human and environmental damage (Renn, 1990). For example, public acceptance of nuclear energy decreased in the United States after both the Three Mile Island and Chernobyl accidents, but the decrease was greater and lasted longer after Three Mile Island than after Chernobyl (Rosa and Dunlap, 1994). In contrast, the *distance effect* occurs because people farther away from the site of an accident have less information about it, and this may amplify their fears and reduce their acceptance of nuclear energy (Coval and Moskowitz, 1999; Garmaise and Moskowitz, 1999; Grinblatt and Keloharju, 2001).

Empirical explorations of the effect of distance on public acceptance of nuclear energy are rare. One reason for this is that fatal nuclear accidents rarely occur, and most studies of public acceptance of nuclear energy focus on a single country (Choi et al., 2000; Corner et al., 2011; Katsuya, 2001; Liu et al., 2008). Therefore, examining the Fukushima disaster is an important opportunity to study the effect of distance from the site of a nuclear accident on public acceptance of nuclear energy.

It is also important to understand a country's accumulated social acceptance of nuclear energy when considering the effect of nuclear disaster on public acceptance. A country's level of dependence on nuclear energy for electricity can be an important proxy for this (Jun et al., 2010). While Middle Eastern countries use fossil fuels and less developed African countries have no experience in operating nuclear power plants, more developed countries in Asia and Europe have an extensive history of operating nuclear power plants, which seems to significantly affect the social acceptance of nuclear energy (Dadwal, 2009; Soentono and Aziz, 2008; Thomson and Horii, 2009).

Some Middle Eastern countries, concerned about the exhaustion of their own natural resources, are now introducing nuclear power facilities (El-Genk, 2008; McDonald and Rogner, 2004), while some European countries are investing in renewable sources for electricity instead of nuclear energy (Jacobsson et al., 2009; Lalic et al., 2011; Resch et al., 2008). Therefore, a country's dependence on nuclear energy seems to be related to its social acceptance of nuclear energy and the development of alternative energy sources. We expect that countries that have a high dependence on nuclear energy and have fewer alternative energy sources will be more sensitive to public acceptance of nuclear energy after a nuclear accident.

In this study, we consider three country-wide factors to determine dependence on nuclear energy: whether nuclear power reactors are in operation, the proportion of nuclear power reactors in operation, and the proportion of the country's entire electrical supply that is generated by nuclear power. It seems that people in a country with operating nuclear power reactors will experience a greater decrease in acceptance of nuclear energy after an accident than people in a country that has no nuclear power reactors. Correspondingly, a higher density of nuclear power reactors in a country and a higher proportion of nuclear power in the country's overall power supply are expected to have a greater negative effect on public acceptance of nuclear energy after an accident.

Conversely, operational experience with nuclear power plants can help a country create a well-designed emergency response system for nuclear plant accidents (Crick et al., 2004). If the emergency response system has proved successful in previous

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