# The Unintended Consequences of Energy Reduction*

How an Act of Environmental Protection Led to the Deaths of Many

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**Abstract**

Nuclear energy is a clean power source that produces electricity while operating with low-carbon emissions. Although nuclear power generation has its advantages, many concerns have been raised regarding its safety after the Fukushima nuclear accident of 2011. This paper analyzes the utilization of nuclear energy, the price of electricity and electricity consumption, and the temperature-mortality relationship in Japan before and after the accident. We reveal that the use of nuclear energy in Japan sharply decreased following the nuclear accident, resulting in a power shortage scare and surge in electricity prices across Japan. This prompted the country's government to push an energy saving mindset to the public, and as a result, electricity consumption plummeted. However, we find that the government's efforts created adverse effects as days with high temperatures coupled with an energy saving mindset led to a higher mortality rate and a shift to fossil fuel dependent energy poses grave consequences to the environment. These findings prompt discussions about the true cost of energy saving.

## 1 Introduction

The 2011 Fukushima nuclear disaster changed the relationship Japanese citizens have with nuclear energy. From the 160,000 Fukushima residents that had to evacuate the city to the citizens who may not have been affected directly, the public as a whole turned their backs against the entire nuclear industry (Do 2019). However, we find that Japan's halt in nuclear energy generation is not without its fatal consequences.

The nuclear disaster was triggered by an earthquake, generating tsunami waves that flooded the Fukushima Daiichi plant and shut off power to its cooling systems, causing the meltdown of three reactor cores and radiation release (*Fukushima Accident* 2024). Fortunately, there was no death toll as a result of radiation exposure; however the aftermath of the accident did not leave the Japanese public unscathed. Thousands of residents' mental and physical health deteriorated as they were forced to evacuate and be permanently relocated (Disease Control and Prevention 2023). According to the CDC, the disaster triggered an increase in deaths among elderly citizens placed in temporary housing and a rise in post-traumatic stress disorder rates among those affected (Disease Control and Prevention 2023). The public lost trust in nuclear energy and demanded the use of nuclear power plants be eradicated from Japan (Suzuki 2019).

As a response to the growing public outcry, the government of Japan took swift action to significantly reduce nuclear power generation by implementing a new energy policy to eliminate nuclear power by 2030 (Suzuki 2019). Before the accident, nuclear energy comprised 25% of Japan's energy market (Suzuki 2019). After the accident, the market share stayed under 1.7% until 2016 (Suzuki 2019). The significant and abrupt reduction in overall power generation caused Japan to steer towards potential countrywide power shortages (Crace 2011). To combat this, the government pushed a power saving campaign to the public (Crace 2011).

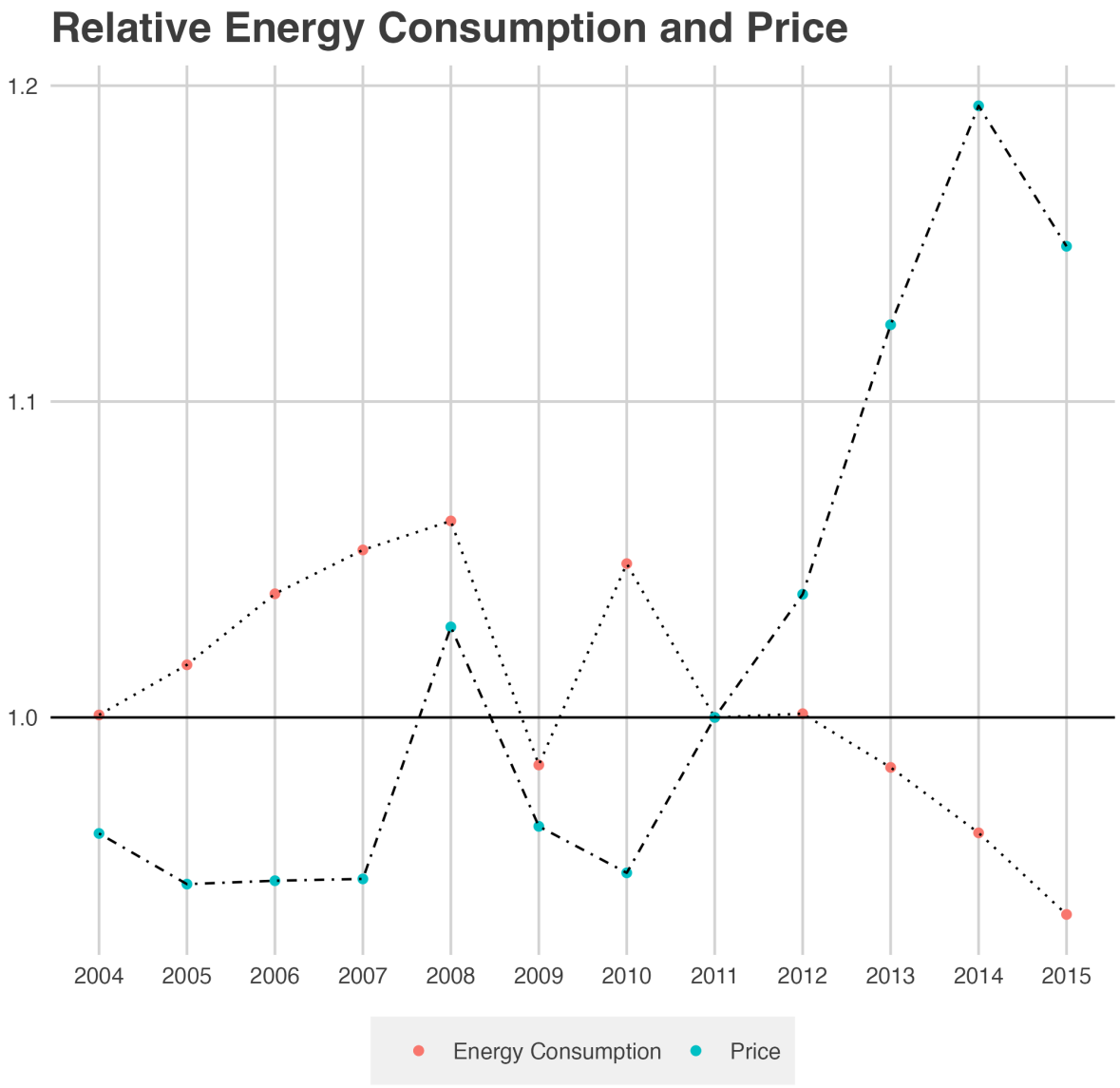
*Code and data are available at: LINK.

In fear of blackouts, energy saving was quickly adopted by Japanese citizens, resulting in a considerable decrease in electricity consumption (Suzuki 2019).

The energy saving campaign was not the sole factor in the sharp decline in energy consumption as the price for electricity also surged. As many nuclear reactors were shut down, fossil fuels grew to dominate Japan's energy market. In 2011, oil usage rose by an estimated 85% while natural gas increased by 25% (Nakano and Pumphrey 2012). This shift to predominate fossil fuel usage had a substantial impact on the price and consumption of electricity as the majority of fossil fuels utilized in Japan are imported from other countries, resulting in expensive prices (Nakano and Pumphrey 2012). Relative to the mean price of electricity in 2011, the price of electricity had increased by over 10% in 2013 and further increased by nearly 20% in 2014 (Nakano and Pumphrey 2012). Consequently, electricity consumption decreased each year as the commodity became less affordable. The Japanese government was successful in reducing energy consumption; however, their energy-saving policies and campaigns cause potential detrimental consequences to the public.

In this paper, we follow He and Tanaka's paper to produce a reproduction of their findings and discuss further about Japan's future as their government reverses their stance on nuclear energy and begins restarting the use of old power plants as a response to fossil fuel shortages and the public pressure to reduce the country's carbon footprint. We analyze the major reduction in energy consumption from 2005 to 2015 caused by the decline in nuclear energy usage, the sharp increase in electricity prices and the energy saving campaign pushed by the Japanese government to investigate their impact on mortality rate in high temperatures. We find that the mortality rate increases as energy consumption decreases. An important finding is that air conditioner usage plays a vital role in preventing deaths related to high temperatures. Therefore, the pressure to conserve energy and hence not utilize air conditioners, increases the mortality rate in Japan.

The remainder of this paper is structured as follows: the Data section details the collection and processing of nuclear energy production, energy consumption and energy price, and temperature-mortality data. Additionally, the section includes discussion on the measurement of the original dataset. The following Results section displays and analyzes tables and figures that illustrate the trends found in the data. The Discussion section draws conclusions from those tables and figures and details the importance of our findings and weaknesses of our paper.


Relative Energy Consumption and Price
1.2
1.1
1.0
2004
2005
2006
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2008
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2012
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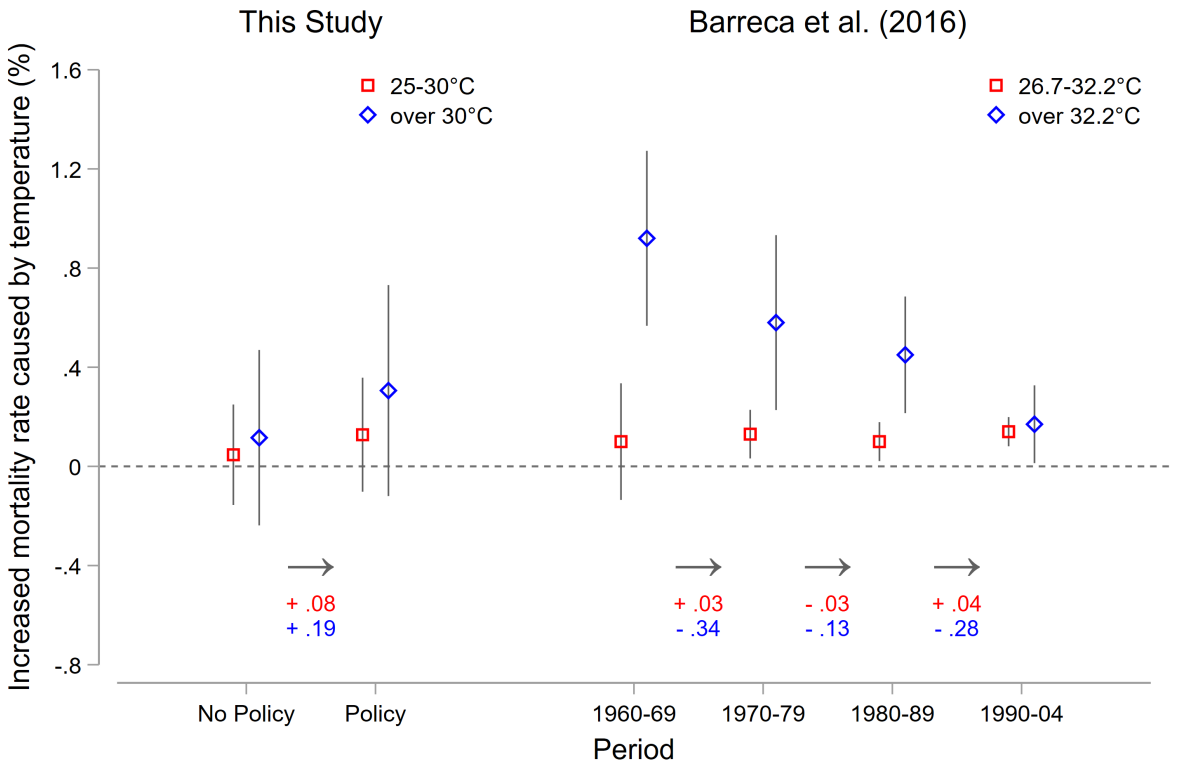
2014
2015
Energy Consumption
Price

FIGURE 1




After the Fukushima incident, the government tried to ensure sufficient backup capacity to avoid power blackouts. While other factors could affect the saving target, the primary determinant of the saving target was a region's dependence on nuclear power before the accident.(Kim, et al.) This caused more health issues for individuals as they were encouraged to not use AC and other cooling devices during hotter days. Previous to the implementation of the energy policy, throughout the period between 1960 and 2004, the mortality rate at over 32.2 degrees Celsius has dropped tremendously while that of between 26.7-32.3 degrees Celsius remained consistent. However, it becomes evident that after the policy implementation, at similar ranges of 25-30 degrees Celsius and over 30 degrees Celsius produced a higher mortality rate. [figure 5]

You can and should cross-reference sections and sub-sections. We use R Core Team (2023) and (**rohan?**).

The remainder of this paper is structured as follows. Section 2....

## 2 Data

Some of our data is of penguins (**?@fig-bills**), from (**palmerpenguins?**).

Talk more about it.

And also planes (**?@fig-planes**). (You can change the height and width, but don't worry about doing that until you have finished every other aspect of the paper - Quarto will try to make it look nice and the defaults usually work well once you have enough text.)

Talk way more about it.

# 3 Model

The goal of our modelling strategy is twofold. Firstly,...

Here we briefly describe the Bayesian analysis model used to investigate... Background details and diagnostics are included in Appendix B.

# 4 Results

Our results are summarized in **?@tbl-modelresults**.

# 5 Discussion

## 5.1 First discussion point

## 5.2 Second discussion point

## 5.3 Third discussion point

## 5.4 Weaknesses and next steps

A few weaknesses with the analysis comes from the limitation of data.The scope of analysis for the post-Fukushima incident and the effects of the energy policy is only Japan. There is no comparison to other countries and their markets trends after nuclear accidents such as Ukraine with the Chernobyl incident. Furthermore, the data is limited only from the Fukushima incident up until 2016 allowing for a short term analysis. The physical effects of nuclear incidents along with the economic effects of the energy policy are both issues that can use a more long term approach. Additionally, there is a lack of robustness as the analysis is fixated on the effects caused by the transition from nuclear energy to fossil fuels. However, there are other energy sources such as renewable energy which includes solar and wind energy that should be taken into consideration.

The next steps would be to find more recent data. As aforementioned, the datasets only extend until 2016 and to complete a long-term analysis, more recent Japanese energy data needs to be collected. Moreover, data from before and after other global nuclear incidents should be gathered and evalauted in comparison to Fukushima to evaluate whether the Japanese government's apporoach was the most optimal. Another step that can be taken to futher the analysis could be to explore more granular effects. For example, in addition to looking at how ambulance calls and heat strokes can be correlated and how increased temperature can cause higher mortality rates before and after the energy policy, other factors such as energy price variation and seasons or energy jobs and employment rates can be observed as well.

# Appendix

# A Additional data details

# B Model details

## B.1 Posterior predictive check

In **?@fig-ppcheckandposteriorvsprior-1** we implement a posterior predictive check. This shows...

In **?@fig-ppcheckandposteriorvsprior-2** we compare the posterior with the prior. This shows...

## B.2 Diagnostics

**?@fig-stanareyouokay-1** is a trace plot. It shows... This suggests...

**?@fig-stanareyouokay-2** is a Rhat plot. It shows... This suggests...

# References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