The Unintended Consequences of Energy Reduction*

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

Yi Fei Pang Irene Hyunh Tara Chakkithara

February 14, 2024

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 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. These findings prompt discussions about the true cost of energy saving.

1 Introduction

The 2011 Fukushima disaster changed the relationship Japanese citizens had 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 industry [science direct].

Before the accident, nuclear energy made up 25% of Japan's energy market. After the accident, the market share stayed under 1.7% until 2016. The Democratic Party of Japan itself took initiative and implemented a new energy policy to "phase out nuclear power," [intchopen] despite formerly having close ties to the industry in attempts to reduce CO2 pollution. [enpolicy one year later]

Fossil fuels grew to dominate Japan's energy market as many reactors were shut down. In 2011 itself, oil usage rose by around 85% while natural gas increased by 25%. [enpolicy one year later]

This change had a huge impact on the price and consumption of electricity. Relative to the mean price of electricity in 2011, by 2013 the price of electricity had increased to over 10% and almost reached an increase of 20% by 2014. Concurrently, electricity consumption itself kept decreasing year after year as it became less affordable. [figure 1]

A good reason for this market shift is that most of the fossil fuels that Japan utilizes are exported from other countries, which makes them expensive. [enpolicy one year later] The lack of nuclear power also reduced more affordable options for consumers.

The trend of increasing electricity prices and decreasing electricity consumption may persist into the future. The current government of Japan reversed the nuclear energy policy, but low public demand for nuclear energy still persists. Thus the prices will stay high as people continue to consume fossil fuels. There are also

*Code and data are available at: LINK.

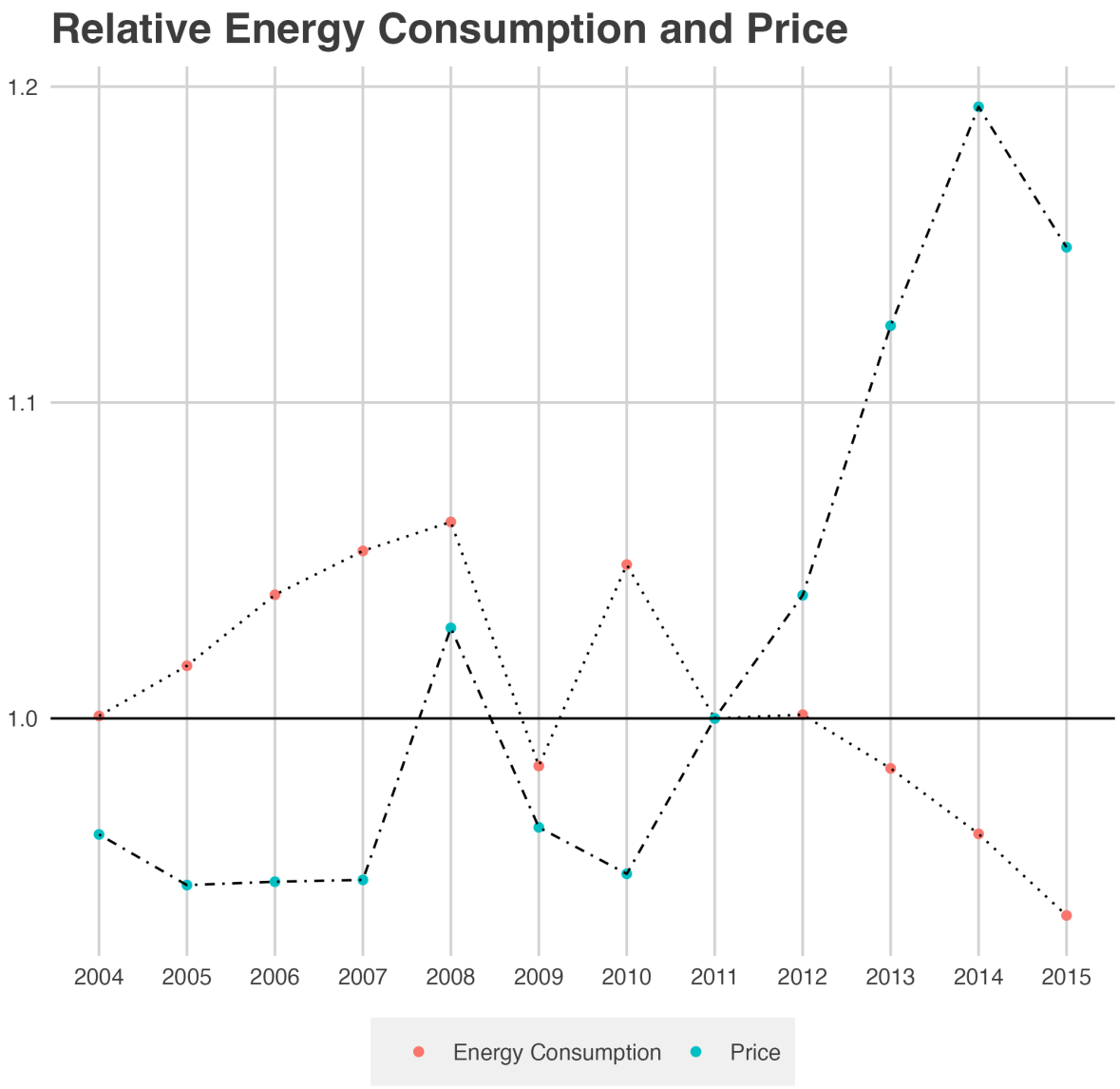

Figure 1: Figure 1

barriers to nuclear power that help to persist this trend. One barrier is the Nuclear Regulation Authority which created tougher safety regulations for reactors. Another are injunctions that citizens can bring forth to prevent the operation of nuclear reactors. After the Fukushima tragedy many courts in Japan may grant these injunctions for safety reasons. [intchopen]

You can and should cross-reference sections and sub-sections. We use R Core Team (2023) and Wickham et al. (2019).

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

2 Data

Some of our data is of penguins (**?@fig-bills**), from Horst, Hill, and Gorman (2020).

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 temperatures and strokes can be correlated (pls verify we did this?), 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

Horst, Allison Marie, Alison Presmanes Hill, and Kristen B Gorman. 2020. *Palmerpenguins: Palmer Archipelago (Antarctica) Penguin Data*. https://doi.org/10.5281/zenodo.3960218.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.