



# Study of the Implications of Japan's Nuclear Wastewater Discharges on Consumer Behavior

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**Abstract.** On 13 January 2023, the Japanese government officially announced plans to release Fukushima nuclear wastewater into the Pacific Ocean. The decision has sparked widespread controversy and skepticism, with responses and initiatives varying from country to country depending on national positions and policy philosophies. This paper scrutinizes the implications of this policy shift for Japan's international trade, with a specific focus on the country's seafood exports and maternity-and-child product markets, which stand at the forefront of stakeholder concerns, and meticulously dissects the multifaceted debate that envelops this issue, drawing from a spectrum of global perspectives that reflect the depth of skepticism and contention surrounding the decision's environmental and health ramifications. By employing a robust econometric approach, this paper leverages the OLS regression to conduct a comparative analysis of sales figures for key Japanese exports, singling out seafood and parent-and-child commodities, across a critical temporal threshold—before and after the public announcement. This paper analyzes the influencing factors of product sales, and tries to see the consumer psychology. Finally, this paper calls on the international community to work together to safeguard the global environment and the common interests of mankind, and suggests that enterprises should consider policy influences in developing market strategies to address potential market challenges.

**Keywords:** Nuclear Wastewater Discharge, Consumer Behavior Research, Big Data Analytics, Linear Regression Analysis

## 1 Introduction

### 1.1 Background of the Incident

On 13 April 2021, the Japanese government announced its decision to release Fukushima nuclear wastewater into the Pacific Ocean within two years. [1] On 13 January 2023, the Japanese government officially decided that it would begin discharging Fukushima nuclear effluent into the ocean during the spring-summer period of 2023.

The Government of Japan has stated that the discharge of nuclear wastewater is considered to be the most feasible and safe way to dispose of nuclear wastewater into the ocean at present, due to the extremely high cost of disposal and the fact that the

nuclear wastewater reservoirs are almost saturated. However, the decision has sparked widespread criticism and skepticism from public opinion at home and abroad, with experts fearing that radioactive material could accumulate on the seabed and somehow enter the marine ecosystem[2]. For the public, this triggered mistrust and protests against Japan's[3]. Neighboring countries are also concerned about the impact of nuclear wastewater discharges on surrounding waters and fisheries[4][5]. The international community has expressed general skepticism about the unilateral decision of the Government of Japan to discharge the sea, which is considered irresponsible and lacking in the spirit of international cooperation.[6] The potential impacts of nuclear wastewater discharges on the environment and human health have become a topic of great concern. At the same time, the decision is also being watched for its possible impact on exports of Japanese products. Against the backdrop of this policy uncertainty, concerns have also arisen about whether nuclear wastewater discharges will have a consumption impact on Japanese products. With exports as the main pillar of its economy, Japan has a good reputation and position in the international market. However, as nuclear wastewater discharges may raise questions about the safety and quality of Japanese seafood, maternal and child products and other food products, Japanese products may face consumer boycotts in the international market, thus affecting Japan's export business and economic development.

It is noteworthy that the Government of Japan seems to have formulated its policy on nuclear wastewater discharges mainly with the cost of treatment and the storage of accumulated nuclear wastewater in mind, without giving sufficient consideration to the potential impact of nuclear wastewater discharges on the export of Japanese products. This has led the industry and academia to re-examine whether the Government's decision-making is well-considered and whether it has adequately weighed up the interests of all parties and the risks that may arise.[7] Against this backdrop, researchers have begun to focus on the impact of nuclear wastewater discharges on the Japanese consumer market, exploring whether policy uncertainty will have a substantial impact on the sales and market credibility of Japanese products. s.

## **1.2 Discussion of the Possible Effects of Nuclear Discharges**

### ***1.2.1 Environmental Impacts of Nuclear Releases and Affected Areas***

The Fukushima nuclear power plant is located at the confluence of three lines of the Japanese Warm Current, the Chishima Cold Current and the North Pacific Warm Current, and based on a general analysis of the direction of the ocean currents, the nuclear effluent may affect not only Japan, but also countries or regions along the Pacific Ocean, including China. Fukushima, is on the east coast of Japan and is at the end of the warm current in Japan, so the nuclear effluent will follow the ocean current and circle around in the North Pacific Ocean before reaching the vicinity of China's Taiwan area.[8] Moreover, China's inland rivers all feed into the water resources along the coast of mainland China, and the strong pressure difference creates a natural water barrier. However, China is still one of the countries closest to Japan, and after Japan announced that it would discharge nuclear wastewater, the Chinese Government and the mainstream opinion in the country still resolutely opposed and resisted it.[9]

According to the algorithm of the GEOMAR Institute in Germany, the results show that within 57 days from the date of the discharge of the Fukushima nuclear effluent, radioactive substances will have spread to most of the Pacific Ocean, and that the United States and Canada will have been affected by the nuclear contamination in three years' time, and will have spread to the world's oceans in 10 years' time. Figures 1-2 below show the Institute's modelling of the risk of marine pollution from nuclear effluent discharges from Fukushima, Japan. In Figure 1& Figure 2, it can be seen that 64 days after Japan's announcement of nuclear effluent discharge into the sea, it will contaminate half of the Pacific Ocean; and 810 days after Japan's announcement of nuclear effluent discharge into the sea, it will contaminate nearly all of the Pacific Ocean. This prediction makes the countries of the world even more opposed to Japan's plan to discharge nuclear effluent from Fukushima into the sea.

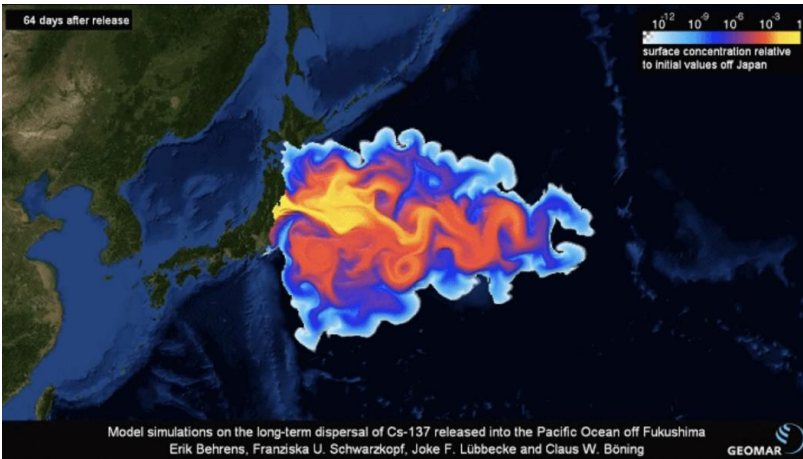


Fig. 1. Predicted nuclear effluent flow for discharges - Day64 (source: GEOMAR)

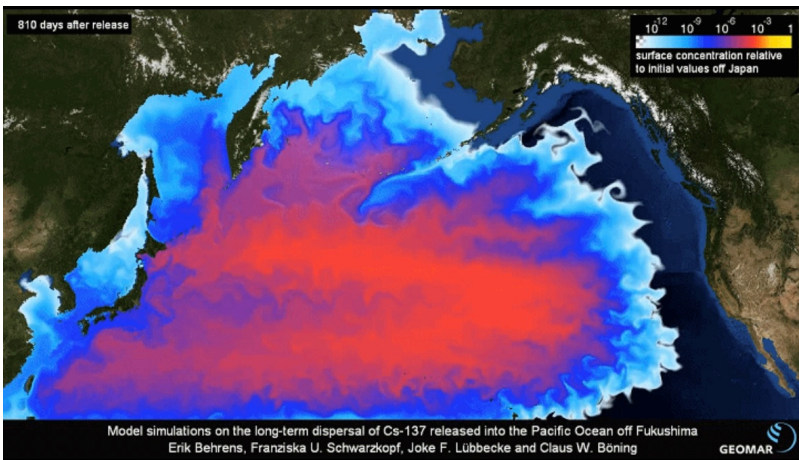


Fig. 2. Predicted nuclear effluent flow for discharges - Day810 (source:GEOMAR)

### ***1.2.2 Questionable Long-Term Safety and Economic Implications***

Although the Japanese government claims to have treated the nuclear effluent using the ALPS system, radioactive substances such as tritium still cannot be completely removed. The actual treatment effect of ALPS has not yet been generally recognized by the international community and its long-term safety is questionable. The impact of nuclear sewage discharges into the sea on the marine environment and the biological chain is unknown. Long-term discharges may accumulate radioactive substances and cause irreversible damage to the marine ecosystem, which in turn affects the quality of Japanese products. Many countries and regions have expressed concern about Japan's practice and have taken corresponding measures, such as mandatory measures to restrict the import of Japanese fishery products.

### ***1.2.3 Ongoing Advocacy for the Discharge of Nuclear Wastewater***

Even though most countries question the safety of Japan's nuclear effluent discharge into the sea, a few countries still support Japan's disposal of nuclear effluent into the sea. According to Yonhap News Agency, on 12 June 2023, South Korean Prime Minister Han Duck-soo said on the issue of Japan's discharge of nuclear wastewater into the sea that if Japan's nuclear wastewater fully meets the standards based on scientific treatment, it can be consumed. The G7 heads of state also stated in their statement that they "support" Japan's discharge of Fukushima nuclear wastewater. The G7 summit includes countries outside the Pacific Ocean, except for Japan, and Japan's discharges into the sea will not have serious direct consequences for them for the time being.[10]

## **1.3 Possible Impact of the Sea Exclusion Announcement on the Consumer Market**

In this paper, we have examined in detail the response of Hong Kong, China, to the discharge of nuclear wastewater from Japan into the sea, and there are significant differences in the level of importance attached and the response of the people among different groups.

First of all, the residents of Hong Kong have generally expressed strong opposition to and concern about this decision. Many people in Hong Kong believe that the discharge of nuclear wastewater may cause irreversible damage to the surrounding waters and may have serious implications for the safety of supplies and the quality of the environment in the region as a whole. As a result, the people of Hong Kong have continued to express their doubts and protests in this regard. At the same time, some residents of Hong Kong may react indifferently or not care about the issue. They may not see it as having a direct impact on their lives, or may lack a full understanding of the potential hazards of nuclear wastewater discharges.

## **2 Sources of Data**

In order to analyze the impact of Japan's nuclear wastewater discharge on consumption, this paper utilizes HKTVmall, the largest local 24-hour e-commerce platform in Hong

Kong, as a data source. This platform brings together a rich and diverse range of products covering categories such as household goods, vegetables and fruits, beauty, electronics and electrical appliances, maternity and babies, pets, household goods and home furnishings, as well as more than 100 internationally renowned brands, to provide diversified choices for a wide range of consumers.

In this study, a comprehensive analysis of sales metrics for seafood and maternal and infant products offered on the HKTVmall marketplace is conducted, focusing on the period preceding and subsequent to the announcement of nuclear wastewater discharge. The objective is to meticulously investigate consumer behavior in response to the environmental concern and quantify its implications on product sales. The dataset encompasses a broad array of key performance indicators, including unit sales volume and revenue post-notification, aggregating over 5 million individual transaction records. Comparison and statistical analysis of these data allowed for the revelation of the extent to which announcements of nuclear wastewater discharges affect consumer purchasing behavior, including possible consumer behavior against nuclear wastewater.

### **3 Analysis of Data**

#### **3.1 The Control Groups**

It may be noted that there is a consumer boycott of certain product categories. If a significant decline in sales volume and sales is observed in some categories of goods, it can be surmised that there is a boycott of these categories among consumers. For example, consumers may have reservations about products from Japan because they are concerned that they are contaminated with nuclear wastewater, or consumers may switch to similar products locally or in other countries.

For this study, the author searched for a control group in Europe and compared it with Japan in terms of average price and average sales. The reasons for selecting Europe and Japan as the control group for the study are as follows:

1. Geographical and cultural similarities: The relative geographical proximity of Europe and Japan has led to some competition between the two regions in the product supply chain.

2. Economic strength and market share: they are both economically powerful regions of the world, and they occupy important positions in both seafood & maternity and baby products markets.

3. Comparison of policy environments: There are some differences in the policy environments of Europe and Japan in terms of environmental protection and food safety.

#### **3.2 Regression Analysis**

Based on the collection of big data on Hong Kong's consumer market, this paper will use a linear regression model to analyze whether the overseas sales of two categories of products that are exported in large quantities from Japan - maternity and baby prod-

ucts and frozen seafood products - are affected by the Japanese government's announcement on sea exclusion, after controlling for other control variables. Table 1 shows the main variable symbols and their interpretation for the regression study:

**Table 1.** Variable symbols and their interpretation

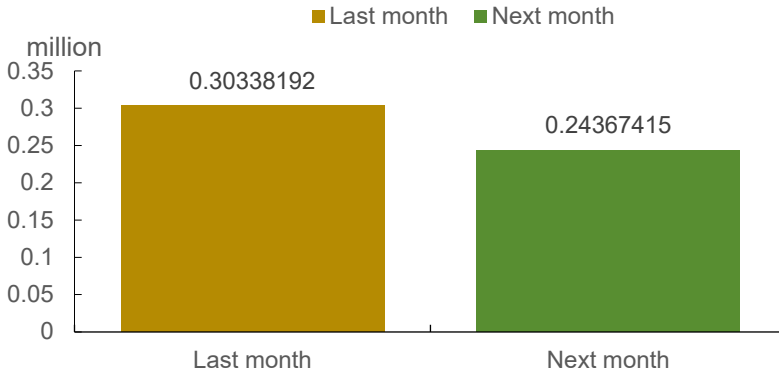
Symbol	Explanations
aveger_price	average unit cost
aveger_discounts	Discount Info
aveger_category	product categories
aveger_weight	Product weights
Sub-Categories	Tier 3 Categorization of the product
is_japan	Place of origin is Japan or not
policy_shock	Whether after the announcement of the sea exclusion policy
is_japan:policy_shock	Interaction term between origin and exclusion policies
total_num	Number of sales

### 3.3 Research Findings

#### 3.3.1 Data Analysis of Maternity and Baby Products

The experimental data covers the sales of maternity and baby products of Japanese and European origin for 30 days before and after the announcement of the nuclear wastewater. From the analysis, it can be seen that the effect of the nuclear wastewater discharge policy on the number of sales of maternity and baby products originating from Japan is significant. After the announcement of the nuclear wastewater, the number of sales of Japanese maternity and baby products showed a significant downward trend, indicating that consumers' concern over the nuclear radiation issue has led to their distrust of products from Japan, and thus they have chosen to avoid purchasing them.

The average sales of maternity and baby products in the previous month of the announcement was 303381.92, while the average sales in the following month was 243674.15. It can be concluded that after the announcement that nuclear wastewater will be discharged into the sea, the sales of Japanese maternity and baby products showed a clear downward trend, and the number of sales may also have decreased significantly (-19.9%). In Europe, the average sales volume decreased by 18.5 per cent. A comparison chart of average sales of Japanese maternity and baby products in the month before and after the announcement date is shown in the Figure 3.



**Fig. 3.** Average sales of Japanese maternity and baby products in the month before and after the announcement day

In order to further analyze the factors affecting the sales volume, this paper conducts regression analysis on the daily sales volume. The result is shown in Table 2

**Table 2.** Linear regression analysis for maternity and baby products

	Maternity and Baby Products (1)	Maternity and Baby Products (2)
Intercept	967.9798*	1512.2980
aveger_price	-8.5500***	-9.0531**
aveger_discounts	17.6418***	17.7737***
aveger_category	—	-44.6236
aveger_weight	—	0.0501
is_japan	1928.0846***	1626.5176
policy_shock	201.8766	209.0116
is_japan:policy_shock	-730.7608***	-738.2106***
Sub-Categories	—	Controlled
Quality	—	Controlled
R-squared	0.779	0.779

It can be found that products with lower price levels and greater discounts tended to sell in high volumes, which is consistent with the fact that consumers often take price into account in their purchasing decisions.

Nuclear wastewater discharge announcements have a clear impact on the daily sales of maternity and baby products. An in-depth analysis of these influencing factors can help to formulate appropriate marketing strategies, so as to better respond to market changes and improve the sales performance of products. The conclusion can be drawn based on the regression analysis (Table 2) that the interaction term between whether the origin is Japan and the impact of nuclear wastewater discharge policy has a significant negative effect on the daily sales. This may mean that the number of sales of maternity and baby products with Japanese origin is relatively lower under the nuclear

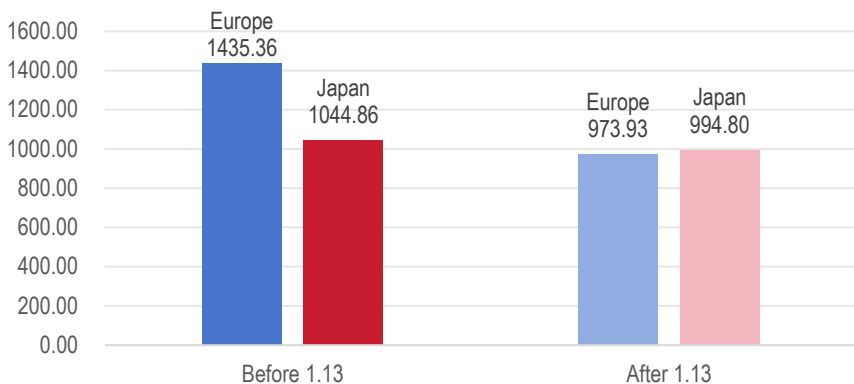
wastewater announcement shock, and consumers may hold more doubts and concerns about these products.

Consumers of maternal and infant products inherently prioritize the health and safety of their children, which amplifies the scrutiny applied to product selection. This demographic is known to exercise extreme caution and perform rigorous due diligence before committing to a purchase, as the well-being of vulnerable infants and expectant maternity is at stake. Prenatal and postnatal periods are typically characterized by an increased sensitivity to potential hazards; hence, exposure to negative information can significantly undermine trust in a product or brand. In light of this, the news of potential radioactive contamination in Japanese-origin products directly challenges the intrinsic need for unassailable safety in maternity-and-child merchandise, compelling consumers to adopt a more guarded and selective shopping behavior to mitigate risks to their offspring and themselves.

### 3.3.2 Data Analysis of Frozen Seafood Products

Similarly, in order to analyze the impact of Japan's nuclear wastewater discharge announcement on the number of frozen seafood products sold, this study conducted a linear regression analysis on the independent variables of price, discount information, whether the origin was Japan, and the impact of the nuclear wastewater discharge policy, using 30 days of pre- and post-sale data for seafood products originating in Japan and Europe (Netherlands, Norway).

As shown in Figure 4, the average daily sales of European seafood dropped significantly after the announcement date by about -32.1%, which is mainly due to the end of the holiday season and the retreat of the hoarding craze leading to the drop in sales, which is a post-holiday off-season phenomenon that occurs every year on the platform, while the average daily sales of Japanese products did not show a significant drop after the announcement, which was only -4.79%, which indicates that the enthusiasm for sales has not diminished



**Fig. 4.** Average daily sales of frozen seafood products before and after the announcement day in Japan and Europe



A linear regression analysis (the result is shown in Table 3) for the factors influencing the sales of frozen seafood products was used to derive the effect of each factor on the number of seafood products sold. The interaction term between whether the origin is Japan and the shock of the exclusion news is found to have a significant effect on the number of sales, suggesting that there is an uptick in sales of Japanese products after the exclusion announcement. Meanwhile, origin or external policy factors are important considerations for consumers when purchasing seafood products, while price and discount information of seafood products have an equally significant impact on the number of sales.

**Table 3.** Linear regression analysis of seafood

	Frozen Seafood (1)	Frozen Seafood (2)
Intercept	2910.0789***	6542.0378**
aveger_price	-18.0283***	-22.7422***
aveger_discounts	32.1005***	33.6957***
aveger_category	—	-935.6507
aveger_weight	—	1.4522
is_japan	-50.2669	-1442.6969
policy_shock	-458.7877***	-454.5032***
is_japan:policy_shock	647.1833***	566.2013**
Sub-Categories	—	Controlled
Quality	—	Controlled
R-squared	0.657	0.681

At the level of consumer behavior of the research object, we found that maternity and baby products will be negatively affected, while seafood products will be hoarding phenomenon in the short term, so it can be seen that the influencing factors of consumer behavior include not only the event itself, but also the differences in the results produced by the influencing event on different things and the consideration of consumer demand.

## 4 Conclusion

Analyzing HKTVmall's sales data, this study reveals how consumers reacted to Japan's decision to release radioactive water, showing a spike in Hong Kong's frozen seafood purchases, including instances of stockpiling, post-announcement. Conversely, there was a notable drop in maternity and baby products purchases, reflecting deep consumer concerns for product safety and quality when influenced by nuclear wastewater issues, directly affecting buying intent for these sensitive categories.

The Japanese government's release of nuclear wastewater has complex economic effects. Initially, it may stimulate related industries and boost Japan's economy. Long-term consequences, however, remain uncertain and potentially negative, given global interconnectedness and concerns over product safety and environmental sustainability. This study highlights the deep concern of consumers about product quality and safety, as well as the growing public sensitivity to food safety and environmental issues. The

current international climate calls for collaboration and adherence to ESG standards. Both businesses and policymakers must prioritize ecological conservation to maintain product integrity and respond to increasing public concern for food and environmental safety through proactive measures.

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