The Run on Daily Foods and Goods after the 2011 Tohoku Earthquake: A Fact Finding Analysis Based on Homescan Data[†]

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Abstract

Using high-frequency scan-based data on purchases by households compiled by a market research firm, this paper examines changes in consumption patterns in the period of confusion immediately after the 2011 Tohoku earthquake. In particular, we focus on the panic buying of foods and daily necessities observed mainly in the Tokyo metropolitan area immediately after the unprecedented disaster. The results of our empirical analysis suggest that the sudden increase in daily expenditure due to panic buying was mainly due to a jump in the share of households that engaged in buying; on the other hand, increases in prices and the quantities that each household purchased were limited. Furthermore, based on regression analyses on items for which panic buying was clearly observed, we found that households that engaged in panic buying appear to have hoarded a wide range of commodities at random (i.e., they purchased rice, bread, noodles, and whatever they could lay their hands on).

Key words: Panic buying, hoarding, earthquake, scanner data, Japan
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1. Introduction

The earthquake that struck Japan on March 11, 2011, off the Pacific coast of Tohoku, known as the 2011 Tohoku earthquake or the Great East Japan Earthquake, with its epicenter approximately 130 kilometers (81 miles) off the east-southeast coast of Miyagi prefecture, was not only the most powerful (magnitude 9) megathrust earthquake ever to hit Japan, but also triggered huge tsunami waves that wreaked severe damage along the Pacific coastal regions from Tohoku to Kanto. The cost of the damage has been estimated to be up to 235 billion USD (or 19 trillion JPY) by the World Bank, and 16-25 trillion JPY by the Japanese government. The earthquake and tsunami inflicted great damage not only on businesses in the Tohoku region, but also on production networks that incorporated Tohoku and East Japan more generally. Furthermore, in the immediate aftermath of the earthquake, disruptions to production and distribution were exacerbated by psychological anxiety, and there was wide-ranging panic buying and hoarding of daily foods, fuel, disaster-related products, etc., in the Tohoku and Kanto regions. Due to fears of a shortage of daily necessities, the Minister of State for Consumer Affairs on March 17 made an exceptional plea to refrain from "hoarding."

There have been a number of attempts to assess the impact of the earthquake on the Japanese economy and society, such as the dedicated chapters in the *Annual Report on the Japanese Economy and Public Finance* (Cabinet Office, 2011; 2012), the paper by Tokui et al. (2012), and a session at the 2012 autumn meeting of the Japanese Economic Association on the "Economic Analysis of the Great East Japan Earthquake," where three papers were presented. However, little progress has been made in studying the period of chaos that immediately followed the earthquake, probably because of the relatively limited data available for the period. For example, Hagiwara (2012) presents an interesting analysis of psychological aspects of consumer behavior in the aftermath of the earthquake. However, the study relies on the analysis of data collected retrospectively and therefore cannot present a detailed picture of post-earthquake panic buying and hoarding. Of interest in this context is also the series of studies by Abe et al. (2011, 2012a, 2012b), which (like the present paper) make use of scanner data and show that despite the jump in demand resulting from the disaster, prices increased only modestly, implying that markets adjusted through rationing rather than through price changes. However, since these studies rely on weekly data for products at a relatively aggregated level and exclude the areas directly affected by the disaster, they do not provide a comprehensive analysis of panic buying in the immediate aftermath of the earthquake, which is the focus of this study.

Specifically, the aim of this study is to examine panic buying/hoarding of food and daily necessities in the Tokyo metropolitan area immediately after the earthquake using daily data on purchases by households compiled by the market research firm INTAGE and kindly provided to us specifically for the purpose of assessing the impact of the 2011 Tohoku earthquake. Although runs on goods and hoarding at times of emergency or in anticipation of prices hikes are not uncommon[1] and have been the subject of study especially in the field of marketing (see, e.g., Blattberg et al., 1981; Erdem et al., 2003), there are almost no empirical studies on the issue in Japan, since the frequency of existing official statistics, which are released on a monthly basis at best, is insufficient to examine a phenomenon that occurs over a short period of time.[2] Yet, gaining a better understanding of runs is of potentially considerable importance. For example, if runs are entirely irrational, it makes sense for policy makers to attempt to calm and reassure the public. Moreover, even if participating in a run is rational from an individual perspective, it may be desirable to take policy measures to prevent a run, if the potential negative externalities are large, such as in the case of a bank run. Moreover, runs may have a destabilizing effect on the business cycle, so that a better understanding of consumer behavior during a period of upheaval such as after the Tohoku earthquake may help to find ways of how to handle possible panics in the future.

Against this background, this study seeks to empirically examine consumer behavior in the period of confusion immediately after the 2011 Tohoku earthquake to detect what types of goods were subject to panic buying, to discover typical patterns of panic buying, and to ascertain the characteristics of the individuals involved in panic buying, using high-frequency scanner data. Specifically, looking at individual items and by decomposing changes in households' average daily expenditures on individual items immediately after the earthquake, we found the following. (1) In the days immediately following the disaster, panic buying in the Tokyo metropolitan area was observed for a wide range of product categories (71 out of 241 categories). (2) The sudden increase in daily expenditure due to panic buying was mainly due to a jump in the share of households that engaged in buying; on the other hand, increases in prices and the quantities that each household purchased were limited. (3) There were only a few items, such as *natto* (fermented soybeans) and yogurt, for which there actually were real prolonged supply shortages in the Tokyo metropolitan area. (4) On the other hand, in the three

[1] Well-known examples in recent Japanese history include the stockpiling of toilet paper during the first oil crisis in 1973 and the surge in consumer spending in anticipation of the consumption tax hike in April 1997.

[2] One notable exception is Statistics Bureau (2011), which focuses on goods the consumption of which was significantly affected by the Tohoku earthquake.

prefectures directly affected by the disaster, there were serious supply shortages for a wide range of items. Furthermore, based on regression analyses on items for which panic buying was clearly observed, we found that (5) panic buying in the Tokyo metropolitan area was more predominant among larger households and households with a middle-aged (or older) full-time homemaker; and that (6) households that engaged in panic buying appear to have hoarded a wide range of commodities at random (i.e., they purchased rice, bread, noodles, and whatever they could lay their hands on).

The remainder of the paper is organized as follows. Section 2 briefly describes the devastation caused by the 2011 Tohoku earthquake and the panic buying by consumers that occurred in the Tokyo metropolitan area immediately after the disaster. Next, Section 3 provides an outline of the *Shakaichosa-kenkyusho Consumer Index* (henceforth, "SCI") data provided by INTAGE, Inc., that we used in our analysis, and expounds the questions that we are going to answer through our empirical analysis. Section 4 then presents the results of our empirical analysis. Finally, Section 5 summarizes the findings and concludes.

2. The 2011 Tohoku earthquake and subsequent turmoil and confusion

The Tohoku earthquake on March 11, 2011, was one of the most powerful known earthquakes (magnitude 9) ever to have hit Japan, and one of the four most powerful earthquakes in the world since modern record-keeping began in 1900. The northern part of Miyagi, the prefecture closest to the epicenter, recorded a seismic intensity of 7 on the scale employed by the Japan Meteorological Agency, which is the maximum and equivalent to intensity IX on the Modified Mercalli Intensity scale, while the intensity in Tokyo was "5-upper" on the Japanese scale. The earthquake triggered powerful tsunami waves that reached heights of up to 40.5 meters (133 ft.) in Miyako in Tohoku's Iwate prefecture, and brought catastrophic destruction along the Pacific coast of Tohoku and Kanto. The number of dead or missing as a result of the disaster is approximately 19,000; more than 380,000 buildings were either completely or partially destroyed; and up to 400,000 people were evacuated.

In documents presented at a ministerial meeting on April 12, the Japanese government estimated that the cost of just the direct material damage was approximately 16-25 trillion JPY (or 300 billion USD), an amount equivalent to the total annual output of the three most-affected prefectures of Iwate, Miyagi, and Fukushima. Further, the earthquake and tsunami incapacitated the reactor cooling systems at Fukushima Daiichi Nuclear Power Plant, resulting in severe releases of radioactivity and the prospect of long-term health and

environmental hazards.

In the immediate aftermath of the disaster, the Nikkei Stock Average fell sharply in response to the potential adverse effects of the earthquake and the nuclear accident. Industrial zones along the Pacific coast of Tohoku and Kanto were severely damaged by inundation from the tsunami. The resulting shutdown of factories and logistical bottlenecks seriously impeded production networks spanning the Tohoku region in particular and East Japan more generally. Even in the Tokyo metropolitan area, which did not suffer any direct damage from the earthquake, business and consumer activity was severely affected due to power supply shortages that resulted in rolling blackouts starting on March 13. Moreover, the radioactive contaminations from the Fukushima Daiichi nuclear disaster as well as the mood of collective self-restraint after the national disaster appear to have had a considerable negative impact on the economy.

Among the wide range of effects of the 2011 Tohoku earthquake, the one this paper will focus on is the short-run impact on household purchasing behavior. In the period immediately after the earthquake, the disruption to production and distribution networks led to shortages of a variety of goods not only in the prefectures directly affected by the disaster but also in the wider Tohoku and Kanto regions. The situation was further exacerbated by psychological strains, which resulted in panic buying. Although sufficient supplies of food, fuel, and emergency goods to meet demand in normal time were available, store shelves were left empty due to panic buying and hoarding of certain foods and other basic supplies in the wake of the earthquake. Empty shelves, in turn, gave rise to a vicious cycle of consumers scrambling to stockpile such goods and the shortages of daily necessities garnered worldwide media attention. Given the destabilizing influence that panic buying had on the supply of goods, numerous government officials pleaded for voluntary restraint from hoarding.[3]

3. Data and research questions

The data used for the analysis in this study comes from the "SCI" individual consumer panel research data collected by INTAGE, Inc., Japan's leading market research company. The panel monitors 12,640 households randomly selected from all prefectures in Japan (except Okinawa). The households, which are restricted to married-couple households comprising two or more members, are asked to scan the barcode of every (non-durable) product they buy, and the scanned data are transferred electronically to INTAGE's datacenter. The scanner data in

[3] See, e.g., the plea by Renho, the Minister of State for Consumer Affairs, on March 17, 2011 (http://www.caa.go.jp/jisin/110317onegai.html).

the dataset provides information such as (1) the date of purchase, (2) the Japanese Article Number, a unique product identifier, (3) the price, and (4) the quantity. The dataset covers more than 10,000 different products in 214 categories, consisting of 146 categories of processed food and 68 categories of daily necessities. Unfortunately, products without barcodes, such as fresh foods, are not covered. The dataset also contains information on household characteristics, such as the age of household members, the occupation of the husband and the wife, the educational background of the husband and the wife, the household size and composition, the standard of living, and the prefecture of residence.

Using this information, we construct a daily panel dataset (with approx. 12,000 households and 214 commodity categories) on household consumption spanning the five month period from January 1 to May 31, 2011, and examine panic buying for each individual product category. Table 1 reports the average daily expenditure of households in the dataset and the distribution of various household characteristics. The table indicates that regardless of the region of residence, average daily household expenditure is around 600 yen, which may give the impression that that the daily expenditure of households in Japan is rather small. However, it should be noted that the "SCI" database covers only a relatively limited part of household consumption, since it only includes non-durable products with a barcode and hence excludes fresh foods, dining out, consumer durables, etc.[4] However, if we calculate the average daily household expenditure for households that purchased at least one item on a day, the amount increases to more than 2,000 yen, since only about 30 percent of households tend to buy items covered by the "SCI" database on any particular day. Turning to household characteristics, single-person households, as mentioned, are excluded from the survey, and the large majority of households consist of more than two household members, i.e., the married couple plus, presumably, their children in most cases. Looking at the occupational status of the wife, about 40 percent are full-time homemakers, while in about half of all households, the occupation is "Other," indicating that the wife works neither as a full-time regular employee nor as a full-time homemaker, but presumably in a part-time and/or non-regular job.

Given that the "SCI" survey covers only married-couple households, we clearly cannot assume that our sample is nationally representative. However, by carefully examining the vast and detailed scan-based "SCI" data, we can get a grasp of the details of what was

[4] Conducting a detailed comparison of INTAGE's SCI data and data from the diary-based Family Income and Expenditure Survey (FIES, an official consumption survey), Abe and Niizeki (2010) find that household expenditures in the former tend to be about 25 to 30 percent smaller than the corresponding expenditures in the latter, while the two datasets exhibit similar age-consumption patterns in most categories.

going on in markets for the selected products. Using the information from the dataset, we seek to address the following questions:

(i) On which commodity categories did panic buying concentrate and what form did this panic buying take?

(ii) What are the particular characteristics of households that engaged in panic buying?

(iii) How was panic buying of individual products correlated with panic buying of other products?

To examine question (i), we compare market developments (average daily household expenditures, unit prices, purchase volumes per household, and the share of households that bought items on any given day) for each of the 214 product categories in the Tokyo metropolitan area, in western Japan, and in the three prefectures directly affected by the disaster,[5] and examine the nature of the panic buying behavior that occurred immediately after the Tohoku earthquake. As for question (ii), narrowing down our focus to 71 commodity categories that the examination of question (i) suggested were subject to panic buying, we examine the purchasing behavior of individual households during the three day period immediately after the earthquake (from March 12 to 14) using probit regressions to identify, for each of the selected product categories, the characteristics of households that engaged in panic buying. Finally, for question (iii), we compare actual household behavior with the prediction of the model estimated to answer question (ii) to identify, for each product, households that were likely to engage in panic buying of that product and examine whether the probability that households engaged in panic buying was significantly higher if such households also engaged in panic buying of other products.

4. Empirical analysis

In this section we outline our empirical strategy to address questions (i), (ii), and (iii) above and report the results of the empirical analyses.

4.1 What sort of goods were subject to panic buying, and what form did panic buying take?

[5] "Tokyo metropolitan area" in this paper refers to the urban parts of Tokyo, Kanagawa, Chiba, and Saitama; the three prefectures directly affected by the disaster are Iwate, Miyagi, and Fukushima; finally, "western Japan" includes the following 23 prefectures: Mie, Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama, Tottori, Shimane, Okayama, Hiroshima, Yamaguchi, Tokushima, Kagawa, Ehime, Kochi, Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, and Kagoshima.

Let us start our analysis by looking at buying patterns around the time of the earthquake in the three regions that we focus on. Figure 1 shows the average daily total household expenditures as recorded in the database of residents in the Tokyo metropolitan area, in the three disaster-affected prefectures, and in western Japan. As can be seen, developments in average daily household expenditures during the week following the earthquake on March 11 differed markedly across the three regions. While expenditures in western Japan remained largely unaffected, average daily expenditures by households residing in the Tokyo metropolitan area surged immediately after the earthquake, implying widespread panic buying, while expenditures by households in the three disaster-affected prefectures dropped substantially.

Given these different patterns, the question naturally arises where these regional differences come from. Can these regional differences be observed uniformly for all individual product categories? What is the main cause of the expenditure fluctuations? In order to find answers to these questions, we examine household-level changes in daily expenditure on individual product categories and decompose changes in expenditures into changes in unit prices, changes in quantities purchased by a household, and changes in the share of households that purchased the product in question on any given day. For illustration, the various panels of Figure 2 present the result for "rice," the first of the 214 product categories. Specifically, Figure 2(a) shows the average daily household expenditures on rice, Figure 2(b) the average price at which a unit of rice was purchased, Figure 2(c) the average purchase volume of rice among households that purchased rice, and Figure 2(d) the share of households that purchased rice on a given day.

Given that

Average daily household expenditure

≡ Average unit price × Average purchase volume

× Share of households that purchased the item,

Figures 2(b) through 2(d) represent a decomposition of Figure 2(a). Examining the figures one by one, we find that, as in the case of total expenditures, there was spike in household expenditures on rice immediately after the earthquake (Figure 2(a)). Further, Figure 2(b) shows that there is little sign of a rise in the unit price of rice. Moreover, while there was a slight increase in the average purchase volume per household (Figure 2(c)), it is clear that the sudden increase in expenditure on rice was largely due to a jump in the share of households

that went out to buy rice during the few days after the earthquake (Figure 2(d)).

Although we cannot report all the results due to space constraints, we prepared similar figures for all the other 213 product categories in the database and classified them into six different groups reflecting the type of household response observed. Moreover, we did so for the Tokyo metropolitan area, as well as for the disaster-affected three prefectures, where we could observe clear post-disaster responses (see Table 2).

The first type of reaction (Type I) we observe is a sudden increase in expenditure on the commodity in question coinciding with a rise in the price or the purchase volume per household. An example, presented in Figure 3, is pot noodles. For the Tokyo metropolitan area, not only do we observe a clear jump in the share of purchasing households, but also a clear increase in the average quantity purchased and a mild increase in the average purchase price. Similar patterns of panic buying in the Tokyo metropolitan area can be observed for a total of 36 of the 214 product categories, although it should be noted that the classification to some extent is based on the authors' intuitive judgment rather than any hard and fast criteria. Particularly notable expenditure increases were observed for 17 product categories, including rice, noodles, and canned food. For instance, at its peak, expenditure on pot noodles was about five times as high as at normal times. As the unit price of pot noodles in the Tokyo metropolitan area only rose by 20 percent (see Figure 3(b)), increases in quantity accounted for the rest of the jump in expenditure. Above all, the drastic increase in the share of households that purchased pot noodles in the days after the earthquake appears to have played the largest role. The drastic increase in the share of purchasing households suggests that many households in the Tokyo metropolitan area purchased the product in question (pot noodles in this case) at shorter intervals than usual, which we can probably interpret as evidence of panic buying of the product in question. On the other hand, for the three disaster-affected prefectures, which presumably were much more directly affected by the disaster, we find almost no products for which this type of panic buying can be observed, except for moderate increases in sales of dry noodles and mineral water.

The next type of reaction, Type II, is defined as a similar sudden increase in expenditures after the earthquake, but with no obvious changes in the price and volume purchased per household (Figure 4 gives the example of nutritionally balanced instant foods, for which this pattern holds for the Tokyo metropolitan area). In the case of a Type II reaction, all of the observed increase in average household expenditure results from an increase in the share of households that went out to buy the product in question, i.e., from a panic run on the

products. While 35 product categories, such as nutritionally balanced instant foods and cling film were subject to a Type II reaction in the Tokyo metropolitan area, the number of product categories subject to this type of reaction in the three disaster-affected prefectures was limited to two, dried tofu and canned meat. As we already saw in Figure 1, there was no noticeable increase (in fact, there was a visible decrease) in total expenditures in the three disaster-affected prefectures. Thus, the analysis at the individual product level confirms that there was no time for households in the directly affected area to engage in panic buying.

The third type of reaction, Type III, is defined as a fall in average expenditure on the product in question in the immediate aftermath of the earthquake, despite a slight increase in the price and/or the purchase volume per household. (Figure 5 show the example of *natto*, or fermented soy beans, for which this pattern holds for the Tokyo metropolitan area). In this case, given the increase in expenditure by those households that purchased (were able to buy) the products in question, the only apparent reason for the drop in average household expenditures is a fall in the share of households that went out to buy these products during the days after the earthquake. Except for unusual products for which the number of households in need of such products fell in response to the disaster, the observed decline in the share of households purchasing these products probably resulted from supply constraints. Only three product categories, i.e., *natto*, yogurt, and milk, were subject to a Type III reaction in the Tokyo metropolitan area. By contrast, in the three disaster-affected prefectures, there were 23 product categories, including not only *natto* and yogurt, but also products such as bread, noodles, cheese, ham, sausages, and tissue paper, displaying this pattern suggesting supply shortages. Therefore, while there were few product categories that were subject to real supply constraints in the Tokyo metropolitan area, in the three disaster-affected prefectures a considerable number of products appear to have been in short supply.

The next type of reaction, Type IV, is defined as the case where again expenditures fell, but without noticeable changes in the unit price and purchase volume per household. (As an illustration, Figure 6 shows the pattern for cook-freeze products in the three disaster-affected prefectures). Although only three product categories, including fried foods, fall under Type IV in the Tokyo metropolitan area, as many as 46 product categories, including fried foods, candy, and toilet paper, fall under this type in the three disaster-affected prefectures, and in the case of cook-freeze products (Figure 6), the shortage appears to have lasted for about a month. These results suggest that a wide range of products were subject to real and prolonged supply shortages in the disaster-affected area.

The fifth type of reaction (Type V) is the case in which we see no clear changes in average daily household expenditure on the product in question, while there is an increase in the price or the purchase volume per household. Type V implies that the share of households that went out to buy the product in question declined in the days after the earthquake. (Figure 7 illustrates this pattern for the case of bread for the Tokyo metropolitan area). A Type V reaction is likely to be observed when demand increases temporarily for commodities that do not preserve well and that are produced and supplied every day to be consumed on that day. Bread and pastries/sandwiches appear to fall into this category for the Tokyo metropolitan area. Five product categories, including spaghetti and tea flavored drinks, in the three disaster-affected prefectures follow a similar pattern, despite the fact that those five product categories preserve relatively well.

The final type of reaction, Type VI, refers to the case when there were no clear changes in expenditures, prices, and purchased volumes before and after the earthquake. (The example of tea is given in Figure 8). In fact, the majority of product categories, that is, more than 130 out of the 214 categories, fall under this Type VI reaction in both the Tokyo metropolitan area and the three disaster-affected prefectures. Given the large number of product categories to which this applies, providing a full list would take up too much space. However, products that experienced neither panic buying nor supply shortages include luxury grocery items, beverages, cleaning products, and daily sundries.

The item-by-item examination of different product categories as well as the decomposition of changes in average daily household expenditures brought to light the following facts regarding household purchasing behavior in the wake of the disaster:

a) During the days immediately after the Tohoku earthquake, panic buying was observed in the Tokyo metropolitan area for a wide range of products (71 of the 214 categories), such as staple foods, noodles, canned goods, etc.
b) The observed increases in average daily expenditures resulting from panic buying were mainly attributable to increases in the share of households that went out to purchase items during the period in question. Increases in prices and purchase volumes per household were limited.
c) Contrary to fears of consumers, only a few products such as *natto* and yogurt saw any real and/or prolonged supply shortages in the Tokyo metropolitan area. In the case of other products, even if they temporarily became difficult to obtain, their availability

returned to normal after the panic period, which at most lasted only a few days.

d) For some products such as bread that do not preserve well and that are produced and supplied on a daily basis to be consumed on that day, we did not witness any significant changes in daily expenditure, even though there may have been some households that were unable to obtain such products when demand for them increased temporarily.

e) On the other hand, we saw almost no surge in average daily household expenditures resulting from panic buying in the three disaster-affected prefectures. Rather, in these prefectures, households appear to have been unable to purchase a wide range of goods due to supply shortages.

Our findings above partly are in line with those of Abe et al. (2011, 2012a, 2012b), who argued that goods prices increased only modestly in the Tokyo metropolitan area after the earthquake despite the excess demand caused by the disaster. However, the detailed analysis here provides a more nuanced picture. While Abe et al. (2012a) simply concluded that the rises in expenditure were caused by increases in the quantities purchased, our decomposition revealed that the overall increase in expenditures was due not to a rise in the amount purchased per household, but to an increase in the number of households that went out shopping (compared to normal) in the days after the earthquake. Further, we think it is safe to say that the observed increase in the number of households that went out shopping was due to the fact that (some) households purchased the products in question at shorter intervals than usual due to anxiety after the disaster.

Moreover, while Abe et al. (2012a) directed their attention to the welfare gap between households that were able to buy storable commodities and those that were not (as a result of quantity rationing), it is more likely that only the products that could not be stored made a real difference to the levels of household welfare of households that could and those that could not obtain those products, as shortages of storable goods were only temporary, and such goods became available as usual after the brief period of panic. And, needless to say, the major differences in welfare were those between households in the disaster area and those elsewhere.

4.2 What kind of households went out panic buying?

Our item-by-item investigation in the preceding section showed that sudden increases in expenditure were observed mainly in the Tokyo metropolitan area for some product

categories, and that such increases were not attributable to price rises or increases in the volume purchased per household but to a much larger share of households rushing out to purchase the products in question during the days just after the disaster. Based on this finding, we analyze households' post-earthquake purchasing behavior for 71 product categories, i.e., those that fall under Type I and Type II purchasing behavior in Table 2, which we identified as having been subject to panic buying during the three day period (March 12 to 14) after the earthquake, and examine for each product category the characteristics of households that engaged in panic buying.

Since we are interested in discovering how purchasing behavior (i.e., whether a household purchased a certain product or not) during the three day period immediately following the earthquake differed from behavior in normal times, our strategy is first to estimate the probability that an individual household would have purchased a certain product during the three day period had there not been an earthquake, and then to compare the estimated probabilities with the actual behavior immediately after the earthquake.

More concretely, since the three day period from March 12 to 14, 2011 ran from Saturday to Monday, we first construct a dataset for the three Saturday-to-Monday periods preceding the earthquake (February 19 to 21; February 26 to 28; and March 5 to 7). We then run the following probit regression to estimate the likelihood that an individual household purchased a certain product during the three-day periods:

$$P(i,j,T)=\begin{cases}1 & if \quad y^{*}_{i,j,T}>0\\ 0 & if \quad y^{*}_{i,j,T}\le 0\end{cases}$$

$$\begin{aligned}y^{*}_{i,j,T} &= \beta_{0,j}+\beta_{1,j}VP(i,j,[t_0,t_0-3])_{i,j,t-1\to t-4}\\ &\quad +\beta_{2,j}VP(i,j,[t_0-4,t_0-10])+\beta_{3,j}VP(i,j,[t_0-11,t_0-40])+\gamma_j Characteristics(i)+u_{i,j,T}\end{aligned} \quad \ldots(1)$$

Here, T represents a particular three day period [t_0+3, t_0+1] following the reference date, t_0. $P(i,j,T)$ is a dummy variable, which takes 1 when the amount spent on product j by household i is positive (i.e., a purchase took place) and 0 otherwise. The explanatory variable $VP(i,j,[t_0, t_0\text{-}3])$ is the quantity of product j purchased by household i during the four day period immediately preceding T; $VP(i,j,[t_0\text{-}4, t_0\text{-}10])$ is the quantity purchased during the week stretching from five days before T to eleven days before T; and $VP(i,j,[t_0\text{-}11, t_0\text{-}40])$ is the quantity purchased during the one month period before that, i.e., twelve days to 41 days before T. Further, *Characteristics(i)* are control variables representing the characteristics of

household *i*, such as a dummy variable that takes 1 when household *i* resides in the Tokyo metropolitan area, a dummy variable that takes 1 when household *i* resides in one of the three disaster-affected prefectures, the number of family members in household *i*, a dummy variable that takes 1 when the wife of household *i* is less than 35 years old, a dummy variable that takes 1 when the wife of household *i* has a regular job, a dummy variable that takes 1 when the wife of household *i* is a college graduate, and so on.

The regression results are shown in Table 3 and are generally in line with what one would expect. For example, the positive coefficient ($\beta_{3,j} > 0$) on the $VP(i,j,[t_0\text{-}11,t_0\text{-}40])$ term implies that the larger the quantity a household *i* would usually purchase of commodity *j*, the higher the probability that it would purchase the same commodity *j* during period *T*. On the other hand, a more recent record of purchase of a particular product had a positive effect on whether they would purchase that product during *T* for some products and a negative effect for others. In the case of rice and *miso*, for example, both $VP(i,j,[t_0\text{-}4,t_0\text{-}10])$ and $VP(i,j,[t_0,t_0\text{-}3])$ have a negative and significant effect on the probability that households would buy those products during the target period *T*. In other words, these are products that tend to be bought in quantities that last for a while and if households had bought them in the eleven days prior to period *T*, they were less likely to buy them during period *T*. However, for other products, such as pot noodles, $VP(i,j,[t_0\text{-}4,t_0\text{-}10])$ often has a positive effect while $VP(i,j,[t_0,t_0\text{-}3])$ has a negative effect. These are products that tend to be bought more frequently, i.e., every few days.

If we assume that households follow more or less regular shopping patterns, so that their shopping habits from Saturday to Monday are relatively similar from one week to the next, we can utilize the estimated probit models above to calculate the probability that household *i* purchased product *j* during the period March 12 to 14, 2011, had there not been the Tohoku earthquake. As we are interested in panic buying in the period immediately after the earthquake, our analysis focuses on how actual purchasing behavior immediately after the Tohoku earthquake deviates from normal pattern as predicted by model (1).

More precisely, focusing on the three day (Saturday-to-Monday) period right after the earthquake (i.e., March 12 to 14, 2011), we run a second stage probit regression and examine the estimated coefficients in order to identify the characteristics of households that engaged in panic buying. Concretely, we estimate the following specification:

$$P(i,j,T)=\begin{cases}1 & if \quad x^{*}_{i,j,T}>0\\ 0 & if \quad x^{*}_{i,j,T}\le 0\end{cases} \quad \text{and} \quad x^{*}_{i,j,T}=\alpha_{0,j}+\alpha_{1,j}\,Pr(P(i,j,T)=1)+\lambda_j Characteristics(i)+\varepsilon_{i,j,T} \ldots(2)$$

$\Pr(P(i,j,T)=1)$ is the probability that household *i* purchased product *j* during period *T* as predicted by model (1). *Characteristics(i)* include a dummy for households residing in the Tokyo metropolitan area resident; a dummy for households residing in one of the three disaster-affected prefectures; a dummy for households residing in a large city; the number of household members; a dummy for middle-aged wives (35-49 years of age); a dummy for older wives (50 years of age and over); a dummy for wives with a regular job; a dummy for college-educated wives; households' subjective standard of living; a dummy for households with small children; etc.

Table 4 shows the results for household characteristics that were found to have been significant, with the plus or minus signs denoting household characteristics that were associated with more or less active purchasing of a particular product immediately after the disaster than during normal times.

To begin with, column (*a*) shows the marginal effects of the predicted value from the first stage probit regression, i.e., model (1). As expected, the coefficients on the purchase probability during normal times (i.e., the prediction from the first stage regressions) is significant and positive ($\alpha_{1,j}>0$) for almost all products. This implies that at least part of the purchasing behavior during the upheaval following the earthquake followed the regular pattern. On the other hand, if there was any panic buying, that should show up as purchasing behavior that is not predicted by the model of purchasing patterns during normal times. Thus, we regard those purchasing patterns that are not explained by the prediction from the first stage regression as panic buying and examine how the deviations from the first stage model of purchasing patterns during normal times are correlated with household characteristics. In other words, we examine what household characteristics play a significant role in explaining purchasing behavior in the days immediately after the disaster after controlling for purchasing patterns during normal times.

Columns (*c*) and (*e*) report the estimated marginal effects of the residential dummies. We find that households in the Tokyo metropolitan area were indeed more likely to engage in panic buying. On the other hand, the likelihood that households in the three disaster-affected prefectures made purchases in the days immediately after the disaster was significantly lower, suggesting that they may have been unable to make purchases. Next, columns (*g*) to (*m*) show the results for various other household characteristics that play a role in explaining purchasing

behavior immediately after the earthquake. We find that the coefficient on the large city dummy, which takes 1 if a household resides in a city with a population of more than 0.6 million, is positive and significant for a considerable number of product categories, and there are only very few for which it is negative and significant. This result implies that panic buying was more widespread in urban areas even after controlling for households residing in the Tokyo metropolitan area and the three disaster-affected prefectures. Turning to other variables, the number of family members also has a significant positive coefficient for many of the product categories, implying that larger households were more likely to go out shopping during the post-earthquake upheaval. Regarding wives' age, households with a middle-aged or older wife were more likely to have engaged in panic buying. Further, regarding the effect of the wife's occupational status, wives without a regular job had a tendency to hoard certain commodities (in other words, wives with a regular job appear not to have had time to engage in panic buying). Next, while no clear pattern emerges regarding the effect of wives' education, wives with a college education had a tendency to hoard certain foods, although we are not sure about the reasons. Unexpectedly, households with a higher subjective living standard appear to have gone out shopping more actively during the post-earthquake upheaval. Finally, the infant dummy, which takes 1 if households have a child or children under the age of four, had a negative effect on the purchase of rice and mineral water, while it had a positive effect on the purchase of diapers.

Summarizing, the general pattern that emerges is that post-disaster panic buying was more predominant among larger households, households in urban areas, households with a middle-aged (or older) wife, and households with a wife without a regular job. Abe et al. (2012a) report that the increase in food expenditures in response to the disaster was smaller for households with a working wife. Our findings appear to broadly agree with theirs on this point. On the other hand, while Abe et al. argue that households with an infant were less likely to make panic purchases during the week immediately after the earthquake, the closer look at individual product categories in this study reveals that there were at least a few products, such as diapers, paper towels, etc., that were subject to panic buying by households with a young child/children.

4.3 How was panic buying of particular products linked with panic buying of other products?

The analysis so far has shown that there was clearly discernible panic buying by households

in the Tokyo metropolitan area and that such panic buying was most conspicuous among households with a large number of family members, households with a middle-aged or older wife, and households in which the wife is not in full-time regular employment. In this section, we take our analysis one step further and for each product category try to identify households that engaged in panic buying. Once we have identified such panic buying households, we can then examine how panic buying of a particular product was linked to panic buying of other products. Examining how panic buying of different products is linked is useful since it allows us to ascertain whether panic buying was "rational" to the extent that households bought noodles as a substitute for rice if the latter was not readily available, or whether panic buying households indiscriminately bought anything they could lay their hands on. This is an issue that, to the best of our knowledge, has not been empirically studied so far.

Our empirical strategy is as follows. We start by identifying households that engaged in panic buying by comparing an individual household's actual shopping pattern immediately after the earthquake with the shopping pattern predicted for that household by model (1). We regard a household as having engaged in panic buying of a certain product if it actually purchased the product during the period immediately after the earthquake even though model (1) predicts for that household that the probability of purchasing that product was low. More concretely, we first calculate the average share of households that purchased an individual product during the three day window in normal times. We then assume that panic buying households for each individual product can be captured by the increase in the share of households buying that product in the three day period immediately after the earthquake and use this to calculate the number of panic buying households for each product. Next, for each household that purchased the product in question during the three day period immediately following the earthquake we calculate the probability of purchase based on model (1) and ordered households in terms of their estimated purchase probability, starting with those with the lowest probability. We then assumed that households with the highest probability up to the rank that is equal to the estimated number of panic buying households are panic buying households.

We applied this procedure to the 71 product categories that the analysis above suggested were subject to panic buying to identify panic buying households for each individual product. Table 5 provides a list of 24 product categories for each of which the procedure identified more than 80 panic buying households. Many of the products in this list are items that one would expect panic buying to concentrate on, such as rice, instant noodles,

canned foods, mineral water, and tissue paper, suggesting that our strategy works well in identifying products for which panic buying by households was particularly pronounced. On the other hand, the identified number of households that are deemed to have engaged in panic buying may look relatively small compared to the proportion of households that according to media reports engaged in panic buying.[6] We suspect this is because our estimates are of the number of panic-buying households for each individual product category, which should be smaller than the number of households that rushed to buy at least one product.

Finally, to examine the links between panic buying of individual products, we estimate augmented probit models, in which, in addition to the variables shown in Table 4, we include 23 product dummies representing whether that household was deemed to have engaged in panic buying of that product. For example, in Table 6, which shows the results, the dependent variable in the first row is a dummy variable that takes 1 when a household purchased rice during the three-day period immediately after the earthquake, while the independent variable in the second column (labeled "002" for "cooked rice") represents whether that household had engaged in panic buying of cooked rice during that same three-day period. The figures reported in the table represent the estimated marginal effect of each dummy, i.e., how much, in the example given above, the probability that a household that panic bought cooked rice also bought rice. We find that many of the estimated marginal effects are positive and significant, indicating that households deemed to have engaged in panic buying of some products had a higher probability of also buying other products. Moreover, this pattern even holds between products that are normally considered to be substitutes, such as rice and noodles, tea in liquid form and mineral water, or tissue paper and toilet paper. Thus, we can say that particularly anxious households appear to have bought anything that they could lay their hands on.

5. Concluding Remarks

Using data on product purchases by households compiled by the market research firm INTAGE and provided to us specifically for the purpose of assessing the impact of the 2011 Tohoku earthquake, this study examined changes in consumption patterns in the wake of the unprecedented disaster. In particular, we focused on the panic buying of foods and daily

[6] There are no official statistics on how many households engaged in panic buying, but a survey conducted by the *Nikkei Shinbun* (morning edition, April 18, 2011) suggests that about 16.5% of households hoarded something after the earthquake. If we apply this share to our total sample, the number of panic buying households in our sample would be 1,850.

necessities observed mainly in the Tokyo metropolitan area immediately after the earthquake.

Specifically, looking at individual items and by decomposing changes in households' average daily expenditures on individual items immediately after the earthquake, we found that in the days immediately following the disaster, panic buying in the Tokyo metropolitan area was indeed observed for a wide range of product categories (71 out of 241 categories). We further found that the observed sudden increases in daily expenditure due to panic buying were mainly due to a jump in the share of households that engaged in buying, while increases in prices and quantities that each household purchased were limited. Moreover, there were only a few items, such as *natto* (fermented soybeans) and yogurt, for which there actually were real prolonged supply shortages in the Tokyo metropolitan area. On the other hand, in the three disaster-affected prefectures, there were serious supply shortages for a wide range of items. As a result, households in the disaster area were unable to purchase a wide range of goods even if they wanted to.

Based on probit regressions to examine the characteristics of households that engaged in panic buying, we found that households in the Tokyo metropolitan area, households with a larger number of family members, households in urban areas, and households with a middle aged or older full-time homemaker wife were likely to engage in panic buying. Furthermore, by identifying panic buying households for each particular product category, we were able to show that households that did engage in panic buying appear to have done so quite randomly for a wide range of products (purchasing rice, bread, noodles, and whatever they could lay their hands on).

Overall, our empirical analysis suggests that the rapid increase in expenditures observed in the Tokyo metropolitan area immediately after the 2011 Tohoku earthquake appears to have resulted not from serious shortages of supply but from panic buying (or hoarding) by a section of particularly anxious households that groundlessly feared a goods shortage. And in the case of households in the Tokyo metropolitan area, even if it became temporarily difficult for them to obtain certain types of goods, such goods became available as usual again after the brief period of panic that lasted only a few days at most. Therefore, those households that were able to purchase goods during the panic period gained very little in terms of welfare relative to those that were not. In contrast, the fact that households in the disaster area appear to have been unable to purchase a wide range of commodities for a prolonged period even if they wanted to presumably lowered their welfare levels considerably. Thus, an important question to examine is whether post-earthquake panic buying in the Tokyo

metropolitan area impeded the smooth supply of goods to the disaster areas and thereby exacerbated the situation for those most directly affected.

Almost two years have passed since the Tohoku earthquake and efforts to assess the impact of the disaster on society and the economy are still ongoing. To date, however, little progress has been made in studying the period of chaos that immediately followed the earthquake, probably due to data constraints. Given the opportunity to use scanner-based individual consumer panel data, we were able to take a first step toward understanding details of the upheaval that followed the earthquake. While it is obvious that scanner-based large-scale datasets are useful not only for marketing science but also for economics and social sciences as well as policy analysis, such dataset are not always readily accessible to the average researcher in Japan. We hope that the environment for data access to facilitate further research will improve in the near future.

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Table 1. Average expenditures and distribution of sample households

(a) Average daily expenditures per household (Total of 214 categories)

	All sample households (Unit: yen)			Average among households with positive expenditures (Unit: yen)			Share of households with positive expenditures (Unit: %)		
	Whole observation period	Before the earthquake	After the earthquake	Whole observation period	Before the earthquake	After the earthquake	Whole observation period	Before the earthquake	After the earthquake
Three disaster-affected prefectures	587	632	549	2,286	2,184	2,398	25.7%	28.9%	22.9%
Tokyo area	663	650	674	2,241	2,189	2,286	29.6%	29.7%	29.5%
Western Japan	612	600	623	2,025	1,996	2,050	30.2%	30.0%	30.4%

(b) Distributions of sample households (Unit: number of households)

Size of the city	Total	More than 600,000	More than 300,000	More than 50,000	Less than 50,000	Town or village
All of Japan	11,372	3,106	2,025	4,749	544	948
Three disaster-affected prefectures	383	68	56	159	11	89
Tokyo area	3,011	1,300	532	1,179	0	0
Western Japan	5,423	1,432	1,054	2,166	261	510

Number of family members	Total	2	3	4	5	6 or more
All of Japan	11,372	2,080	2,955	4,041	1,585	711
Three disaster-affected prefectures	383	59	103	128	57	36
Tokyo area	3,011	503	803	1,188	390	127
Western Japan	5,423	1,019	1,425	1,854	784	341

Age of wife	Total	Under 35	35—49	Over 50
All of Japan	11,372	2,098	4,381	4,893
Three disaster-affected prefectures	383	73	142	168
Tokyo area	3,011	523	1,184	1,304
Western Japan	5,423	1,017	2,070	2,336

Age of household head	Total	Under 35	35—54	Over 55
All of Japan	11,372	1,485	5,569	4,318
Three disaster-affected prefectures	383	56	183	144
Tokyo area	3,011	362	1,510	1,139
Western Japan	5,423	717	2,628	2,078

Occupation of wife	Total	Regular employment	Other employment	Full-time homemaker
All of Japan	11,372	1,620	5,522	4,230
Three disaster-affected prefectures	383	43	189	151
Tokyo area	3,011	356	1,463	1,192
Western Japan	5,423	821	2,587	2,015

Occupation of household head	Total	Professional, technical, or managerial job	Self-employed	Office work	Laborer	Agriculture, fishery, or forestry	Unemployed
All of Japan	11,372	2,717	1,074	2,023	4,216	226	1,116
Three disaster-affected prefectures	383	82	33	62	151	8	47
Tokyo area	3,011	865	285	628	920	43	270
Western Japan	5,423	1,204	532	906	2,106	130	545

Educational background of wife	Total	Junior High.	Senior High.	College grad.
All of Japan	11,372	498	7,403	3,471
Three disaster-affected prefectures	383	21	286	76
Tokyo area	3,011	122	1,853	1,036
Western Japan	5,423	216	3,455	1,752

Standard of living	Total	Upper class	Above average	Below average	Lower class	Unknown
All of Japan	11,372	2,724	2,554	2,916	3,123	55
Three disaster-affected prefectures	383	63	70	112	134	4
Tokyo area	3,011	1,032	712	687	560	20
Western Japan	5,423	1,140	1,240	1,400	1,624	19

Annual income of household	Total	Rank1 (low income)	Rank2	Rank 3	Rank 4	Rank5 (High income)	Unknown
All of Japan	11,372	2,500	2,795	2,112	1,931	1,631	403
Three disaster-affected prefectures	383	113	102	67	49	33	19
Tokyo area	3,011	487	639	568	591	593	133
Western Japan	5,423	1,278	1,412	986	885	698	164

Household expenditures	Total	Rank1 (low expend.)	Rank2	Rank 3	Rank 4	Rank5 (High expend.)	Unknown
All of Japan	11,372	2,514	2,501	2,096	2,064	2,142	55
Three disaster-affected prefectures	383	101	99	77	57	45	4
Tokyo area	3,011	451	542	525	629	844	20
Western Japan	5,423	1,311	1,237	1,025	960	871	19

Table 2. Types of consumers' reaction to the Tohoku earthquake

	Tokyo area	Three disaster-affected prefectures
I Expenditure increased with price/quantity increases		
Large changes	**17 categories:** Rice, Cooked rice, Cereals, Instant noodles in pouch, Pot noodles, Dry noodles, Spaghetti, Curry, Pasta sauce, Soups, Miso and other Japanese soups, Canned seafood, Canned meat, Biscuits and crackers, Tissue paper, Toilet paper, Sanitary goods	**0 categories:**
Medium changes	**19 categories:** Raw or boiled noodles, Macaroni, Flour, Pre-mixed bread flours, Mayonnaise, Dried tofu, Salad oil, Margarine, Mix for rice and toppings in green tea, Mix for rice dish, Stew, Sausages, Sausages made from fish meat, Snacks, Rice crackers, Desserts, Tea flavored drinks, Tea in liquid form, Paper towels	**2 categories:** Dry noodles, Mineral water
II Expenditure increased without price/quantity increases		
Large changes	**5 categories:** Nutritionally balanced instant foods, Isotonic drinks, Mineral water, Plastic cling film, Wet tissues	**0 categories:**
Medium changes	**30 categories:** Miso, Bonito flakes, Cheese, Dried laver seaweed, *Furikake*, Canned vegetables, Canned fruits, Western foods, Chinese foods, Bacon, Seasoned beans, *Tsukudani*, Chocolate, Candies, Barley tea, Coca Cola, Aluminium foil, Disposable diapers, Dog food, Cat food, etc.	**2 categories:** Dried tofu, Canned meat
III Expenditure decreased with price/quantity increases		
Large changes	**1 category:** *Natto* (fermented soy beans)	**5 categories:** Bread, Pastries and sandwiches, *Natto* (fermented soy beans) Tofu, Yogurt
Medium changes	**2 category:** Yogurt, Milk	**19 categories:** Instant noodles in pouch, Pot noodles, Raw or boiled noodles, Sugar, Cheese, Dried laver seaweed, Mix for rice dish, Milk, Curry, Ham, Sausage, Fish cake, Biscuits and crackers, Desserts, Isotonic drinks, Tissue paper, etc.
IV Expenditure decreased without price/quantity increases		
Large changes	**0 categories:**	**0 categories:**
Medium changes	**3 categories:** Fried fish cakes, Hair care products, Hair dye	**46 categories:** Cereals, Salad dressing, Butter, Jam and marmalade, Pasta sauce, Frozen vegetables, Cook-freeze products, Western foods, Chinese foods, Fried fish cakes, Chocolate, Candies, Snacks, Rice crackers, Ice cream, Sparkling beverages, Beer, Toilet paper, etc.
V No clear changes in expenditure but with smaller # of purchasers		
	2 categories: Bread, Pastries and sandwiches	**5 categories:** Spaghetti, Canned seafood, *Tsukudani*, Tea flavored drinks, etc.
VI No panic or visible impact		
	135 categories: Flour for fried foods, Salad dressing, Spices, Other seasonings, Vinegar, Flavor enhancer, Sesame oil, Other oils used for cooking, Frozen vegetables, Other frozen food products, Fresh cream, Whipped cream, Soy bean milk, Regular coffee, Tea, Cocoa, Malt beverages, Japanese green tea, Chinese tea, Fruit juice, Sparkling beverages, Whiskey, Wine, *Sake*, *Shochu*, Toothbrushes, Toothpaste, Dental rinse, Soap, Hair treatment Powdered detergent, Bleach, Fabric softener, Laundry starch, Kitchen detergent, Cleanser, Detergent for household, Plastic gloves for cleaning, Wipes, Sponges, Insecticide, Air freshener, Deodorant, Dehumidifying agent, Cotton swabs, Pet-related goods, Photographic film, etc.	**135 categories:** Regular coffee, Tea, Cocoa, Malt beverages, Japanese green tea, Barley tea, Chinese tea, Vegetable juice, Coca Cola, Toothbrushes, Coffee flavored drinks, Whiskey, Wine, *Sake*, *Shochu*, Toothpaste, Dental rinse, Shampoo, Hair treatment, Hair dye, Hair-growth tonic, Powdered detergent, Laundry starch, Kitchen detergent, Cleanser, Detergent for household, Bleach, Detergent for bathroom, Plastic gloves for cleaning, Wipes, Sponges, Insecticide, Air freshener, Deodorant, Dehumidifying agent, Plastic cling film, Aluminium foil, Wet tissues, Disposable diapers, Sanitary goods, Adhesive bandages, Cotton swabs, Dog food, Cat food, Photographic film, Shavers, etc.

Table 3. First stage probit regressions for prediction

Code	Category	Amount of purchases from t_0 to t_0-3			Amount of purchases from t_0-4 to t_0-10			Amount of purchases from t_0-11 to t_0-40			Log likelihood	Pseudo R-squared	# of obs.	Number of households	Share of households with positive expenditures
		Coeff.	Std. error		Coeff.	Std. error		Coeff.	Std. error						
		(*a*)	(*b*)		(*c*)	(*d*)		(*e*)	(*f*)		(*g*)	(*h*)	(*i*)	(*j*)	(*k*)
001	Rice	-0.481	0.051	***	-0.068	0.028	**	0.306	0.011	***	-6,329	0.088	30,581	10,988	6.0%
002	Cooked rice	0.002	0.071		0.066	0.043		0.167	0.019	***	-1,303	0.061	30,581	10,988	0.8%
005	Cereals	-0.023	0.087		0.202	0.052	***	0.357	0.023	***	-2,088	0.113	30,581	10,988	1.5%
011	Instant noodles in pouch	-0.056	0.026	**	0.040	0.016	**	0.099	0.006	***	-6,786	0.030	30,581	10,988	6.1%
012	Pot noodles	-0.021	0.008	**	0.026	0.005	***	0.055	0.002	***	-10,154	0.057	30,581	10,988	11.3%
013	Dry noodles	0.033	0.063		0.127	0.040	***	0.192	0.016	***	-1,816	0.053	30,581	10,988	1.2%
014	Raw or boiled noodles	-0.045	0.008	***	0.011	0.006	*	0.064	0.002	***	-13,295	0.060	30,581	10,988	17.5%
015	Spaghetti	-0.115	0.048	**	0.001	0.030		0.131	0.012	***	-5,061	0.024	30,581	10,988	4.1%
016	Other pasta such as macaroni	-0.043	0.106		0.100	0.065		0.230	0.029	***	-2,194	0.029	30,581	10,988	1.4%
021	Flour	0.062	0.052		0.051	0.039		0.194	0.016	***	-3,424	0.031	30,581	10,988	2.5%
025	Pre-mixed bread flours	0.078	0.062		0.089	0.045	**	0.173	0.018	***	-3,537	0.029	30,581	10,988	2.6%
102	Miso	-0.255	0.058	***	-0.078	0.035	**	0.203	0.014	***	-5,361	0.029	30,581	10,988	4.4%
123	Mayonnaise	-0.255	0.053	***	-0.066	0.032	**	0.115	0.014	***	-5,883	0.014	30,581	10,988	4.9%
126	Various essences	0.507	0.147	***	0.154	0.079	*	0.140	0.038	***	-737	0.044	30,581	10,988	0.4%
143	Bonito flakes	-0.008	0.087		0.057	0.056		0.225	0.021	***	-2,568	0.034	30,581	10,988	1.7%
146	Seasoning soy sauce	0.020	0.035		0.065	0.024	***	0.131	0.008	***	-5,651	0.033	30,581	10,988	4.8%
151	Dried tofu	-0.040	0.186		0.106	0.127		0.290	0.048	***	-1,211	0.034	30,581	10,988	0.7%
161	Salad oil (vegetable oil)	-0.059	0.045		0.063	0.031	**	0.154	0.013	***	-5,945	0.022	30,581	10,988	5.0%
172	Margarine	-0.446	0.081	***	0.034	0.037		0.231	0.015	***	-4,727	0.033	30,581	10,988	3.7%
173	Cheese	-0.009	0.018		0.039	0.013	***	0.107	0.005	***	-9,134	0.042	30,581	10,988	9.4%
175	Other spreads	0.101	0.080		0.173	0.051	***	0.299	0.022	***	-2,286	0.079	30,581	10,988	1.6%
181	Dried laver seaweed	-0.066	0.046		0.102	0.027	***	0.165	0.011	***	-4,501	0.039	30,581	10,988	3.5%
182	*Furikake* (seasoned dried food)	-0.049	0.030		0.047	0.020	**	0.118	0.008	***	-5,880	0.042	30,581	10,988	5.1%
183	Mix for rice and toppings in green t	0.163	0.120		0.131	0.088		0.236	0.031	***	-1,621	0.041	30,581	10,988	1.0%
184	Mix for rice dish	0.016	0.030		0.054	0.024	**	0.146	0.010	***	-5,429	0.036	30,581	10,988	4.5%
201	Curry	-0.075	0.020	***	0.006	0.013		0.062	0.006	***	-8,474	0.014	30,581	10,988	8.1%
202	Stew	-0.068	0.075		0.050	0.042		0.142	0.016	***	-3,170	0.023	30,581	10,988	2.2%
203	Pasta sauce	-0.005	0.034		0.060	0.022	***	0.123	0.009	***	-4,599	0.039	30,581	10,988	3.6%
205	Prepared materials for cooking	0.077	0.029	***	0.083	0.020	***	0.154	0.008	***	-6,177	0.045	30,581	10,988	5.5%
211	Soups	0.048	0.024	**	0.055	0.016	***	0.117	0.006	***	-5,579	0.050	30,581	10,988	4.8%
212	Miso and other Japanese soups	-0.022	0.045		0.080	0.031	**	0.169	0.012	***	-3,790	0.040	30,581	10,988	2.8%
231	Canned seafood	0.010	0.026		0.048	0.021	**	0.117	0.008	***	-5,254	0.030	30,581	10,988	4.3%
232	Canned vegetables	0.017	0.046		0.089	0.034	***	0.160	0.013	***	-3,508	0.042	30,581	10,988	2.6%
233	Canned fruits	0.136	0.041	***	0.117	0.035	***	0.229	0.019	***	-1,974	0.060	30,581	10,988	1.3%
234	Canned meat	0.512	0.137	***	-0.220	0.358		0.321	0.042	***	-512	0.088	30,581	10,988	0.3%
235	Other canned food	0.186	0.268		0.221	0.164		0.156	0.069	**	-391	0.052	30,581	10,988	0.2%

Notes: Reported coefficients are marginal effects, i.e., the partial effect of each explanatory variable on the probability that each product is purchased during the period in question. In addition to the explanatory variables above, regressions also includes several dummy variables that capture the characteristics of individual households, as explained in the main text.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 3 (Continued) First stage probit regressions for prediction.

Code	Category	Amount of purchases from t_0 to t_0-3			Amount of purchases from t_0-4 to t_0-10			Amount of purchases from t_0-11 to t_0-40			Log likelihood	Pseudo R-squared	# of obs.	Number of households.	Share of households with positive expenditures
		Coeff.	Std. error		Coeff.	Std. error		Coeff.	Std. error						
		(*a*)	(*b*)		(*c*)	(*d*)		(*e*)	(*f*)		(*g*)	(*h*)	(*i*)	(*j*)	(*k*)
241	Japanese foods	0.069	0.039	*	0.108	0.030	***	0.186	0.012	***	-2,624	0.090	30,581	10,988	1.9%
242	Western foods	0.025	0.026		0.104	0.019	***	0.167	0.007	***	-5,845	0.088	30,581	10,988	5.4%
243	Chinese foods	-0.013	0.025		0.136	0.016	***	0.156	0.007	***	-6,065	0.085	30,581	10,988	5.6%
252	Sausages	-0.090	0.015	***	0.001	0.009		0.111	0.004	***	-11,928	0.051	30,581	10,988	14.4%
253	Ham made from fish meat	-0.267	0.207		0.299	0.118	**	0.421	0.066	***	-351	0.154	30,581	10,988	0.2%
254	Sausages made from fish meat	-0.135	0.068	**	0.178	0.034	***	0.255	0.014	***	-3,495	0.075	30,581	10,988	2.7%
256	Bacon	-0.165	0.046	***	0.113	0.030	***	0.268	0.012	***	-5,666	0.064	30,581	10,988	5.0%
274	Seasoned beans	0.047	0.062		0.026	0.042		0.312	0.019	***	-2,346	0.127	30,581	10,988	1.8%
275	*Tsukudani* (foods boiled in soy)	-0.021	0.039		0.116	0.028	***	0.219	0.012	***	-4,706	0.063	30,581	10,988	3.9%
301	Chocolate	0.001	0.008		0.039	0.004	***	0.047	0.002	***	-11,659	0.057	30,581	10,988	14.1%
303	Candies	0.017	0.015		0.054	0.011	***	0.089	0.004	***	-7,779	0.061	30,581	10,988	7.7%
305	Biscuits and crackers	0.022	0.012	*	0.067	0.009	***	0.085	0.004	***	-11,096	0.053	30,581	10,988	12.9%
306	Snacks	-0.002	0.008		0.029	0.005	***	0.064	0.002	***	-11,915	0.082	30,581	10,988	15.3%
307	Rice crackers	-0.007	0.012		0.057	0.008	***	0.096	0.003	***	-11,791	0.062	30,581	10,988	14.4%
310	Nutritionally balanced instant foods	0.102	0.036	***	0.114	0.024	***	0.138	0.015	***	-828	0.124	30,581	10,988	0.5%
322	Desserts	0.048	0.014	***	0.066	0.010	***	0.084	0.004	***	-7,580	0.060	30,581	10,988	7.4%
377	Barley tea	0.083	0.145		-0.410	0.199	**	0.265	0.040	***	-1,688	0.033	30,581	10,988	1.0%
421	Coca Cola	0.060	0.019	***	0.058	0.013	***	0.109	0.006	***	-4,306	0.085	30,581	10,988	3.7%
442	Tea flavored drinks	0.096	0.029	***	0.101	0.020	***	0.140	0.007	***	-3,451	0.130	30,581	10,988	2.9%
443	Tea in liquid form	0.061	0.012	***	0.047	0.008	***	0.078	0.004	***	-5,703	0.086	30,581	10,988	5.3%
461	Isotonic drinks	0.022	0.022		0.023	0.013	*	0.105	0.006	***	-3,996	0.063	30,581	10,988	3.2%
462	Functional beverage	0.025	0.031		0.052	0.018	***	0.118	0.010	***	-1,677	0.060	30,581	10,988	1.1%
464	Mineral water	-0.004	0.020		0.042	0.014	***	0.107	0.007	***	-2,590	0.102	30,581	10,988	2.0%
701	Plastic cling film	-0.140	0.055	**	0.014	0.034		0.098	0.014	***	-4,362	0.012	30,581	10,988	3.3%
702	Aluminium foil	-5.266	41788.7		-0.084	0.117		0.151	0.035	***	-1,718	0.016	30,581	10,988	1.0%
721	Tissue paper	-0.090	0.038	**	-0.005	0.025		0.124	0.009	***	-6,272	0.022	30,581	10,988	5.4%
722	Toilet paper	-0.241	0.041	***	-0.104	0.029	***	0.136	0.010	***	-7,344	0.020	30,581	10,988	6.7%
724	Paper towels	-0.235	0.106	**	-0.033	0.069		0.211	0.025	***	-2,676	0.023	30,581	10,988	1.8%
725	Wet tissues	-0.008	0.107		0.117	0.083		0.221	0.029	***	-1,141	0.086	30,581	10,988	0.7%
727	Disposable diapers	-0.366	0.087	***	-0.040	0.047		0.230	0.020	***	-1,340	0.329	30,581	10,988	1.2%
728	Disposable diapers for adults	-0.068	0.138		0.141	0.079	*	0.351	0.031	***	-527	0.181	30,581	10,988	0.3%
741	Sanitary goods	-0.045	0.044		-0.036	0.034		0.141	0.012	***	-3,926	0.051	30,581	10,988	3.0%
782	Disposable body warmers	0.008	0.100		0.134	0.037	***	0.133	0.012	***	-1,126	0.073	30,581	10,988	0.7%
801	Dog food	0.022	0.017		0.028	0.009	***	0.065	0.004	***	-2,657	0.116	30,581	10,988	2.1%
802	Cat food	-0.018	0.013		-0.005	0.009		0.078	0.004	***	-1,546	0.219	30,581	10,988	1.3%

Table 4. Second stage probit regressions to examine the characteristics of households which hoarded the respective products

Code	Category	Prediction of the first stage probit dF/dx (a)	Std. Err. (b)	Tokyo area dummy dF/dx (c)	Std. Err. (d)	Three disaster-affected prefecture dummy dF/dx (e)	Std. Err. (f)	City size (large=1) (g)	Family size (h)	Wife's age (young=0) (i)	Wife's occupation (regular=1) (j)	Wife's education (univ.=1) (k)	Standard of living (l)	Infant (with a child/children aged 0-3 = 1) (m)	Log likelihood (n)	Pseudo R2 (o)	Number of observations (p)
001	Rice	0.417	0.029 ***	0.042	0.006 ***	-0.035	0.010 **			+ (middle)				-	-2,693	0.073	11,252
002	Cooked rice	0.174	0.040 ***	0.026	0.004 ***	-0.011	0.004	+				+			-945	0.071	11,252
005	Cereals	0.204	0.026 ***	0.040	0.005 ***	-0.018	0.005 **		+			+			-1,436	0.077	11,252
011	Instant noodles in pouch	0.406	0.057 ***	0.070	0.008 ***	-0.061	0.008 ***	+	+	+					-3,190	0.033	11,252
012	Pot noodles	0.644	0.044 ***	0.104	0.009 ***	-0.124	0.009 ***	+							-4,578	0.052	11,252
013	Dry noodles	0.180	0.041 ***	0.047	0.005 ***	-0.007	0.007				-				-1,372	0.067	11,197
014	Raw or boiled noodles	0.792	0.036 ***	0.067	0.009 ***	-0.139	0.010 ***		-	+					-4,883	0.066	11,252
015	Spaghetti	0.513	0.092 ***	0.043	0.006 ***	-0.029	0.009 **	+	+	+ (middle)			+		-2,480	0.036	11,252
016	Other pasta such as macaroni	0.332	0.079 ***	0.020	0.004 ***	-0.010	0.004			+ (middle)		+			-956	0.048	11,252
021	Flour	0.403	0.050 ***	0.018	0.004 ***	-0.019	0.005 **							+	-1,517	0.035	11,252
025	Pre-mixed bread flours	0.554	0.090 ***	0.022	0.005 ***	-0.007	0.009	-	+						-1,651	0.037	11,252
102	Miso	0.330	0.064 ***	0.015	0.005 ***	-0.024	0.007 **			+ (middle)	-				-1,989	0.023	11,252
123	Mayonnaise	0.611	0.127 ***	0.024	0.005 ***	-0.039	0.005 ***	+							-2,089	0.021	11,197
126	Various essences	0.197	0.087 **	0.002	0.002										-339	0.048	10,821
143	Bonito flakes	0.335	0.051 ***	0.002	0.003								+		-911	0.060	10,821
146	Seasoning soy sauce	0.271	0.045 ***	0.016	0.005 ***	-0.026	0.006 ***			+	-				-1,886	0.031	11,252
151	Dried tofu	0.392	0.085 ***	0.006	0.002 ***	0.007	0.007		+	+					-548	0.056	11,197
161	Salad oil (vegetable oil)	0.487	0.076 ***	0.013	0.005 ***	-0.027	0.008 **	+			+				-2,159	0.022	11,252
172	Margarine	0.388	0.055 ***	0.012	0.004 ***	-0.024	0.006 **								-1,705	0.025	11,197
173	Cheese	0.585	0.041 ***	0.018	0.006 ***	-0.066	0.007 ***		+		-		+	-	-3,194	0.050	11,252
175	Other spreads	0.138	0.020 ***	0.006	0.003 **	-0.010	0.002 *						+		-786	0.073	11,252
181	Dried laver seaweed	0.289	0.046 ***	0.010	0.004 **	-0.028	0.005 ***								-1,794	0.023	11,252
182	*Furikake* (seasoned dried food)	0.545	0.055 ***	0.037	0.006 ***	-0.031	0.009 **						-		-2,511	0.042	11,252
183	Mix for rice and toppings in green tea	0.386	0.099 ***	0.011	0.003 ***	-0.012	0.003 *						+		-915	0.038	11,197
184	Mix for rice dish	0.418	0.048 ***	0.026	0.005 ***	-0.033	0.006 ***			+ (middle)					-2,068	0.042	11,252
201	Curry	0.556	0.109 ***	0.070	0.008 ***	-0.071	0.010 ***	+	+		-	+	+	-	-3,583	0.032	11,252
202	Stew	0.297	0.083 ***	0.010	0.003 ***			-	+						-965	0.029	10,872
203	Pasta sauce	0.487	0.059 ***	0.042	0.006 ***	-0.041	0.005 ***		+	+ (middle)					-2,183	0.058	11,252
205	Prepared materials for cooking	0.454	0.040 ***	0.016	0.005 ***	-0.034	0.007 ***								-2,183	0.046	11,252
211	Soups	0.391	0.039 ***	0.047	0.006 ***	-0.044	0.005 ***	+	+	+					-2,275	0.061	11,252
212	Miso and other Japanese soups	0.197	0.037 ***	0.026	0.005 ***	-0.010	0.008		+	+					-1,597	0.032	11,197
231	Canned seafood	0.526	0.061 ***	0.066	0.007 ***	-0.040	0.008 ***	+		+					-2,665	0.046	11,252
232	Canned vegetables	0.256	0.040 ***	0.016	0.004 ***							+			-1,356	0.042	10,872
233	Canned fruits	0.122	0.024 ***	0.017	0.004 ***	-0.012	0.004 *	+	+				+		-1,040	0.039	11,197
234	Canned meat	0.088	0.027 ***	0.017	0.003 ***	0.000	0.004	+	+						-425	0.116	11,252
235	Other canned food	0.109	0.191	0.003	0.001 **	0.000	0.003					-	-		-253	0.066	10,260

Notes: Reported coefficients are marginal effects, i.e., the partial effect of each explanatory variable on the probability that each product is purchased during the period in question. The +/- marks in columns (*g*) to (*m*) indicate the sign of significant coefficients, or significant effects of respective explanatory variables on the probability that each commodity is purchased during the 3-day period from March 12 to 14.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 4. (Continued) Second stage probit regressions to examine the characteristics of households which hoarded the respective products

Code	Category	Prediction of the first stage probit		Tokyo area dummy		Three disaster-affected prefecture dummy		City size (large=1)	Family size	Wife's age (young=0)	Wife's occupation (regular=1)	Wife's education (univ.=1)	Standard of living	Infant (with a child/children aged 0-3 = 1)	Log likelihood	Pseudo R2	Number of observations
		dF/dx	Std. Err.	dF/dx	Std. Err.	dF/dx	Std. Err.										
		(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)	(*g*)	(*h*)	(*i*)	(*j*)	(*k*)	(*l*)	(*m*)	(*n*)	(*o*)	(*p*)
241	Japanese foods	0.142	0.020 ***	0.006	0.003 *	-0.008	0.006			+			+		-1,212	0.045	11,252
242	Western foods	0.315	0.025 ***	0.018	0.005 ***	-0.035	0.005 ***		+		-				-2,051	0.070	11,252
243	Chinese foods	0.333	0.023 ***	-0.003	0.004	-0.036	0.003 ***	-		+					-1,911	0.073	11,197
252	Sausages	0.752	0.043 ***	0.035	0.008 ***	-0.105	0.008 ***								-4,217	0.050	11,252
253	Ham made from fish meat	0.007	0.011	0.000	0.001										-173	0.078	10,821
254	Sausages made from fish meat	0.275	0.033 ***	0.023	0.005 ***	-0.027	0.005 ***			+					-1,730	0.037	11,252
256	Bacon	0.419	0.031 ***	0.012	0.005 ***	-0.037	0.004 ***			+ (middle)					-2,024	0.063	11,252
274	Seasoned beans	0.158	0.017 ***	0.009	0.003 ***					+	-				-904	0.085	10,821
275	*Tsukudani* (foods boiled in soy)	0.341	0.033 ***	0.024	0.005 ***	-0.021	0.007 **	+		+		+		-	-1,948	0.058	11,252
301	Chocolate	0.609	0.039 ***	0.055	0.008 ***	-0.095	0.012 ***		+		-	+			-4,409	0.050	11,252
303	Candies	0.506	0.035 ***	0.039	0.007 ***	-0.057	0.008 ***				-				-3,132	0.045	11,252
305	Biscuits and crackers	0.719	0.040 ***	0.057	0.008 ***	-0.099	0.010 ***								-4,320	0.052	11,252
306	Snacks	0.617	0.031 ***	0.035	0.008 ***	-0.109	0.010 ***		+						-4,414	0.074	11,252
307	Rice crackers	0.617	0.033 ***	0.063	0.008 ***	-0.091	0.011 ***			+					-4,377	0.061	11,252
310	Nutritionally balanced instant foods	0.026	0.016	0.015	0.003 ***	-0.004	0.004								-597	0.055	11,252
322	Desserts	0.496	0.031 ***	0.018	0.006 ***	-0.060	0.005 ***								-2,760	0.060	11,252
377	Barley tea	0.126	0.065 *	0.003	0.002				+	-			+		-688	0.046	10,821
421	Coca Cola	0.212	0.021 ***	0.014	0.004 ***	-0.028	0.005 ***		+						-1,787	0.051	11,252
442	Tea flavored drinks	0.208	0.018 ***	0.016	0.004 ***	-0.019	0.005 **		+	-				-	-1,450	0.075	11,197
443	Tea in liquid form	0.346	0.027 ***	0.053	0.007 ***	-0.034	0.010 ***			+ (middle)					-2,724	0.058	11,252
461	Isotonic drinks	0.203	0.028 ***	0.033	0.005 ***	-0.018	0.007 *	+							-1,783	0.035	11,252
462	Functional beverage	0.079	0.020 ***	0.013	0.003 ***	-0.005	0.005								-771	0.037	11,197
464	Mineral water	0.207	0.032 ***	0.038	0.005 ***	-0.033	0.005 ***					-	+	-	-1,935	0.050	11,252
701	Plastic cling film	0.571	0.171 ***	0.022	0.005 ***	-0.024	0.007 **			- (old)		-		-	-1,949	0.020	11,252
702	Aluminium foil	0.385	0.187 **	0.005	0.003 **	-0.001	0.005								-678	0.035	11,197
721	Tissue paper	0.524	0.070 ***	0.044	0.006 ***	-0.054	0.007 ***	+	+						-2,785	0.036	11,252
722	Toilet paper	0.615	0.081 ***	0.044	0.007 ***	-0.047	0.009 ***			+					-2,989	0.033	11,252
724	Paper towels	0.195	0.051 ***	0.012	0.003 ***	-0.009	0.005							+	-1,045	0.029	11,252
725	Wet tissues	0.148	0.048 ***	0.015	0.003 ***	-0.005	0.005								-808	0.060	11,197
727	Disposable diapers	0.029	0.007 ***	0.006	0.002 ***	-0.004	0.001 *			-				+	-597	0.289	11,252
728	Disposable diapers for adults	0.032	0.008 ***	0.001	0.001	-0.001	0.001			+		-		+	-247	0.138	10,852
741	Sanitary goods	0.393	0.069 ***	0.023	0.004 ***	-0.025	0.004 ***		+	-					-1,704	0.070	11,252
782	Disposable body warmers	0.066	0.024 ***	0.010	0.003 ***			+				+			-661	0.043	10,821
801	Dog food	0.166	0.018 ***	0.000	0.003	-0.013	0.004 *					-	+	-	-1,081	0.086	11,197
802	Cat food	0.087	0.010 ***	0.004	0.002 **	-0.004	0.004			+		-			-669	0.146	10,852

Table 5. Commodities for which more than 80 households engaged in panic buying

Code	Product Category	Number of observations	Share of households purchasing in normal times	Estimated number of households purchasing in normal times	Actual share of households purchasing in the three-day period after the earthquake	Number of households purchasing in the three-day period after the earthquake	Number of households that are deemed to have panic bought the product in the three-day period after the earthquake
		(*a*)	(*b*)	(*c*)=(*a*)x(*b*)	(*d*)	(*e*)=(*a*)x(*d*)	(*f*)=max((*e*)-(*c*), 0)
001	Rice	11,252	6.0%	675	7.2%	811	136
002	Cooked rice	11,252	0.8%	88	1.9%	208	120
005	Cereals	11,252	1.5%	167	3.1%	350	183
011	Instant noodles in pouch	11,252	6.1%	684	8.6%	971	287
012	Pot noodles	11,252	11.3%	1,274	15.4%	1,740	466
013	Dry noodles	11,197	1.2%	129	2.9%	326	197
015	Spaghetti	11,252	4.1%	456	6.1%	687	231
025	Pre-mixed bread flours	11,252	2.6%	288	3.5%	399	111
182	*Furikake* (seasoned dried food)	11,252	5.1%	571	6.2%	703	132
201	Curry	11,252	8.1%	911	10.2%	1,152	241
203	Pasta sauce	11,252	3.6%	411	5.3%	595	184
211	Soups	11,252	4.8%	539	5.6%	629	90
231	Canned seafood	11,252	4.3%	483	6.8%	767	284
254	Sausages made from fish meat	11,252	2.7%	302	3.7%	425	123
303	Candies	11,252	7.7%	869	8.5%	960	91
305	Biscuits and crackers	11,252	12.9%	1449	14.0%	1,582	133
443	Tea in liquid form	11,252	5.3%	595	7.1%	809	214
461	Isotonic drinks	11,252	3.2%	358	3.9%	441	83
464	Mineral water	11,252	2.0%	224	4.4%	501	277
701	Plastic cling film	11,252	3.3%	369	4.3%	483	114
721	Tissue paper	11,252	5.4%	606	7.1%	805	199
722	Toilet paper	11,252	6.7%	750	7.8%	885	135
725	Wet tissues	11,197	0.7%	77	1.5%	169	92
741	Sanitary goods	11,252	3.0%	339	3.8%	433	94

Table 6. The link between panic buying of one product and panic buying of other products

Code	Product category (Dependent var.)	Independent variables (code)																									Log likelihood	Pseudo R2	Number of observations
		001	002	005	011	012	013	015	025	182	201	203	211	231	254	303	305	443	461	464	701	721	722	725	741				
001	Rice		0.031*	0.006	0.034***	0.024**	0.051***	0.054***	0.065***	0.004	0.013	0.001	0.064**	0.042***	0.057***	0.020	0.020	0.021	0.049*	0.072***	0.025	0.113***	0.028	0.045**	0.100***	-2,578	0.1122	11,252
			(0.022)	(0.016)	(0.016)	(0.012)	(0.020)	(0.020)	(0.029)	(0.018)	(0.015)	(0.015)	(0.034)	(0.017)	(0.027)	(0.026)	(0.022)	(0.017)	(0.032)	(0.020)	(0.024)	(0.028)	(0.022)	(0.028)	(0.037)			
002	Cooked rice	-0.001		0.010*	0.008	0.021***	0.027***	0.006	0.011	0.010	0.002	0.010	0.012	0.033***	0.010	0.011	0.001	0.004	0.010	0.026***	0.001	0.016**	0.017**	0.011	0.029**	-860	0.1537	10,852
		(0.007)		(0.008)	(0.006)	(0.007)	(0.011)	(0.007)	(0.012)	(0.009)	(0.005)	(0.009)	(0.015)	(0.011)	(0.010)	(0.012)	(0.008)	(0.007)	(0.014)	(0.010)	(0.008)	(0.010)	(0.012)	(0.011)	(0.019)			
005	Cereals	0.002	0.014		0.008	0.027***	0.030***	0.016*	0.030**	0.050***	-0.004	0.017	0.009	0.005	0.006	0.026*	-0.007	0.032***	0.029*	0.048***	-0.002	0.055***	-0.003	0.021*	0.006	-1,353	0.1302	11,252
		(0.011)	(0.013)		(0.008)	(0.009)	(0.013)	(0.011)	(0.020)	(0.021)	(0.006)	(0.013)	(0.017)	(0.007)	(0.011)	(0.021)	(0.008)	(0.014)	(0.021)	(0.014)	(0.010)	(0.019)	(0.009)	(0.016)	(0.014)			
011	Instant noodles in pouch	0.056**	0.073***	0.068***		0.083***	0.146***	0.072***	0.045*	0.070***	0.063***	0.082***	0.070**	0.079***	0.045**	-0.046**	0.070***	0.061***	0.041	0.100***	0.026	0.039**	0.061***	0.083***	0.052*	-2,948	0.1066	11,252
		(0.028)	(0.029)	(0.024)		(0.017)	(0.029)	(0.022)	(0.029)	(0.029)	(0.021)	(0.026)	(0.036)	(0.020)	(0.026)	(0.013)	(0.030)	(0.022)	(0.033)	(0.022)	(0.025)	(0.021)	(0.028)	(0.035)	(0.033)			
012	Pot noodles	0.037	0.193***	0.139***	0.111***		0.067***	0.052**	0.022	0.098***	0.139***	0.017	0.134***	0.166***	0.165***	0.073**	0.056*	0.158***	0.072*	0.212***	0.104***	0.055**	0.158***	0.209***	0.080**	-4,251	0.1201	11,252
		(0.032)	(0.043)	(0.033)	(0.026)		(0.028)	(0.025)	(0.034)	(0.037)	(0.029)	(0.025)	(0.048)	(0.028)	(0.043)	(0.042)	(0.033)	(0.032)	(0.043)	(0.030)	(0.040)	(0.028)	(0.041)	(0.052)	(0.043)			
013	Dry noodles	0.007	0.048***	0.017**	0.030***	0.005		0.050***	0.020*	-0.007	0.020***	0.051***	0.044***	0.043***	0.036***	-0.009	-0.009	0.016*	0.034**	0.012*	-0.001	0.047***	0.021**	0.008	0.029**	-1,244	0.1543	11,197
		(0.012)	(0.019)	(0.011)	(0.011)	(0.006)		(0.016)	(0.015)	(0.006)	(0.010)	(0.017)	(0.024)	(0.013)	(0.017)	(0.007)	(0.006)	(0.011)	(0.022)	(0.009)	(0.009)	(0.018)	(0.014)	(0.011)	(0.020)			
015	Spaghetti	0.044**	0.055***	0.011	0.075***	0.015	0.099***		0.041**	0.066***	0.086***	0.259***	0.105***	0.032***	0.072***	-0.009	0.010	0.005	0.010	0.032**	0.073***	0.024	0.018	0.037*	0.017	-2,260	0.1214	11,252
		(0.024)	(0.024)	(0.015)	(0.019)	(0.011)	(0.024)		(0.025)	(0.027)	(0.022)	(0.035)	(0.039)	(0.015)	(0.027)	(0.018)	(0.020)	(0.013)	(0.025)	(0.015)	(0.030)	(0.018)	(0.019)	(0.025)	(0.024)			
025	Pre-mixed bread flours	0.045***	0.010	0.051***	0.024**	0.024***	0.043***	0.025**		0.017	0.031***	0.019	0.028	0.013	0.020	-0.002	0.027*	0.026**	0.004	0.010	0.019	0.004	0.025*	0.030*	0.008	-1,576	0.0810	11,252
		(0.022)	(0.014)	(0.019)	(0.012)	(0.010)	(0.017)	(0.014)		(0.016)	(0.014)	(0.014)	(0.023)	(0.010)	(0.016)	(0.015)	(0.020)	(0.014)	(0.017)	(0.010)	(0.018)	(0.011)	(0.017)	(0.021)	(0.017)			
182	*Furikake* (seasoned dried food)	0.037*	0.024	0.070***	0.055***	0.015	0.066***	0.104***	0.033		0.032**	0.063***	0.039*	0.042***	0.031*	0.020	0.007	0.032**	0.101***	0.055***	0.067***	0.018	0.030	0.086***	0.079***	-2,346	0.1052	11,252
		(0.024)	(0.020)	(0.022)	(0.018)	(0.011)	(0.021)	(0.024)	(0.025)		(0.017)	(0.022)	(0.029)	(0.016)	(0.022)	(0.026)	(0.019)	(0.017)	(0.041)	(0.017)	(0.028)	(0.017)	(0.022)	(0.033)	(0.033)			
201	Curry	0.054**	0.078***	0.044**	0.093***	0.082***	0.093***	0.072***	0.103***	0.049**		0.049**	0.145***	0.113***	0.104***	0.045	0.032	0.036*	0.035	0.090***	-0.002	0.040*	0.066***	0.115***	0.060**	-3,368	0.0899	11,252
		(0.029)	(0.030)	(0.023)	(0.022)	(0.017)	(0.026)	(0.024)	(0.037)	(0.029)		(0.024)	(0.045)	(0.024)	(0.034)	(0.035)	(0.028)	(0.022)	(0.035)	(0.022)	(0.024)	(0.023)	(0.031)	(0.040)	(0.036)			
203	Pasta sauce	0.032*	0.045***	0.038***	0.026**	0.004	0.065***	0.237***	0.031*	0.026*	0.047***		0.123***	0.030***	0.061***	0.033	0.030*	0.042***	0.019	0.035***	-0.001	0.001	0.05'***	-0.009	0.015	-1,977	0.1464	11,252
		(0.021)	(0.021)	(0.017)	(0.013)	(0.008)	(0.019)	(0.031)	(0.022)	(0.019)	(0.017)		(0.039)	(0.013)	(0.024)	(0.027)	(0.021)	(0.017)	(0.024)	(0.014)	(0.014)	(0.012)	(0.024)	(0.012)	(0.022)			
211	Soups	0.019	0.088***	0.063***	0.040***	0.029***	0.060***	0.043***	0.035*	0.025	0.042***	0.071***		0.036***	0.023	0.044**	0.042**	0.021	-0.006	0.030***	0.041**	0.001	-0.007	0.023	0.019	-2,144	0.1149	11,252
		(0.020)	(0.028)	(0.021)	(0.015)	(0.011)	(0.019)	(0.017)	(0.023)	(0.019)	(0.017)	(0.022)		(0.015)	(0.019)	(0.027)	(0.024)	(0.016)	(0.018)	(0.014)	(0.025)	(0.014)	(0.014)	(0.021)	(0.022)			
231	Canned seafood	0.049**	0.119***	0.037**	0.075***	0.072***	0.113***	0.019	0.011	0.088***	0.056***	0.032**	0.085***		0.046**	0.015	0.029	0.054***	-0.009	0.055***	0.023	0.062***	0.067***	0.085***	0.000	-2,448	0.1234	11,252
		(0.025)	(0.032)	(0.019)	(0.019)	(0.015)	(0.025)	(0.015)	(0.020)	(0.030)	(0.019)	(0.019)	(0.036)		(0.025)	(0.024)	(0.023)	(0.020)	(0.019)	(0.017)	(0.023)	(0.023)	(0.027)	(0.033)	(0.020)			
254	Sausages made from fish meat	0.030**	0.035**	0.037***	0.026***	0.021***	0.026***	0.028**	0.032**	0.059***	0.008	0.022*	0.001	0.012		0.002	0.013	0.031***	0.012	0.002	0.024	0.027**	0.039**	0.057***	0.060***	-1,643	0.0855	11,252
		(0.019)	(0.019)	(0.016)	(0.012)	(0.010)	(0.014)	(0.014)	(0.021)	(0.023)	(0.011)	(0.015)	(0.016)	(0.010)		(0.016)	(0.016)	(0.016)	(0.020)	(0.009)	(0.019)	(0.015)	(0.021)	(0.026)	(0.028)			
303	Candies	0.028	0.060**	0.069***	0.016	0.053***	0.055***	0.021	0.030	0.117***	0.019	0.017	-0.007	0.075***	0.053**		0.071***	0.091***	0.083***	0.050***	0.050**	0.023	0.024	0.149***	0.080***	-2,983	0.0900	11,252
		(0.025)	(0.029)	(0.025)	(0.016)	(0.015)	(0.023)	(0.018)	(0.028)	(0.034)	(0.018)	(0.020)	(0.025)	(0.021)	(0.028)		(0.030)	(0.025)	(0.039)	(0.019)	(0.030)	(0.020)	(0.024)	(0.042)	(0.037)			
305	Biscuits and crackers	0.110***	0.121***	0.080***	0.079***	0.067***	0.090***	0.060***	0.108***	0.16***	0.03134	0.03967	0.148***	0.111***	0.120***	0.158***		0.143***	0.01236	0.098***	0.02468	0.079***	0.04527	0.03794	0.120***	-4,103	0.0999	11,252
		(0.036)	(0.038)	(0.029)	(0.024)	(0.018)	(0.029)	(0.026)	(0.040)	(0.036)	(0.023)	(0.027)	(0.048)	(0.025)	(0.038)	(0.048)		(0.031)	(0.036)	(0.025)	(0.032)	(0.029)	(0.032)	(0.035)	(0.044)			
443	Tea in liquid form	0.064***	0.041**	0.050***	0.021*	0.087***	0.02406	0.0111	0.0041	-0.0097	0.0018	0.033*	0.02435	0.081***	0.035*	0.00048	0.037*		0.244***	0.171***	0.047**	0.035**	0.011	0.085***	0.009	-2,527	0.1258	11,252
		(0.028)	(0.024)	(0.021)	(0.014)	(0.016)	(0.017)	(0.015)	(0.021)	(0.015)	(0.013)	(0.020)	(0.028)	(0.020)	(0.024)	(0.022)	(0.024)		(0.052)	(0.025)	(0.027)	(0.020)	(0.019)	(0.033)	(0.023)			
461	Isotonic drinks	0.024	0.051***	0.060***	-0.004	0.029***	0.011	0.004	0.006	0.042***	0.007	0.026**	0.049**	0.018*	0.018	0.064***	0.005	0.087***		0.023**	0.011	0.024*	0.004	0.042**	0.024	-1,684	0.0888	11,252
		(0.018)	(0.022)	(0.019)	(0.008)	(0.010)	(0.012)	(0.011)	(0.016)	(0.021)	(0.011)	(0.016)	(0.028)	(0.012)	(0.017)	(0.030)	(0.015)	(0.022)		(0.012)	(0.017)	(0.015)	(0.014)	(0.024)	(0.022)			
464	Mineral water	0.023	0.099***	0.051***	0.040***	0.055***	0.006	-0.011	-0.001	0.027*	0.029***	0.031**	0.025	0.037***	0.001	0.004	0.007	0.104***	0.019		0.008	0.004	0.023*	0.108***	0.054***	-1,780	0.1258	11,252
		(0.018)	(0.028)	(0.019)	(0.014)	(0.013)	(0.011)	(0.008)	(0.014)	(0.018)	(0.014)	(0.017)	(0.023)	(0.014)	(0.013)	(0.017)	(0.015)	(0.023)	(0.020)		(0.016)	(0.012)	(0.017)	(0.034)	(0.027)			
701	Plastic cling film	0.017	0.021	0.011	0.007	0.037***	0.008	0.052***	0.024	0.018	0.030**	0.033**	0.033	0.016	0.057***	0.023	0.004	0.026**	0.037*	0.028***		0.099***	0.046***	0.110***	0.078***	-1,819	0.0857	11,252
		(0.017)	(0.017)	(0.013)	(0.010)	(0.012)	(0.012)	(0.018)	(0.020)	(0.017)	(0.015)	(0.017)	(0.025)	(0.012)	(0.024)	(0.023)	(0.015)	(0.015)	(0.027)	(0.013)		(0.024)	(0.021)	(0.034)	(0.032)			
721	Tissue paper	0.076***	0.080***	0.067***	0.034**	0.037***	0.065***	0.03**	0.003	0.034*	0.041***	0.021	0.000	0.036***	0.055***	-0.014	0.028	0.045***	0.042	0.085***	0.108***		0.260***	0.090***	0.124***	-2,564	0.1122	11,252
		(0.029)	(0.029)	(0.022)	(0.016)	(0.013)	(0.022)	(0.018)	(0.021)	(0.024)	(0.018)	(0.018)	(0.023)	(0.016)	(0.026)	(0.019)	(0.024)	(0.019)	(0.032)	(0.020)	(0.034)		(0.042)	(0.034)	(0.039)			
722	Toilet paper	0.059***	0.07'***	0.044**	0.058***	0.062***	0.031*	0.071***	0.074***	0.015	0.022	0.027	0.010	0.046***	0.024	-0.005	0.044**	0.044***	0.059**	0.077***	0.042*	0.282***		0.095***	0.156***	-2,743	0.1123	11,252
		(0.028)	(0.028)	(0.021)	(0.018)	(0.015)	(0.019)	(0.022)	(0.032)	(0.021)	(0.017)	(0.019)	(0.026)	(0.017)	(0.022)	(0.022)	(0.027)	(0.020)	(0.034)	(0.020)	(0.026)	(0.036)		(0.035)	(0.042)			
725	Wet tissues	0.007	0.012*	0.005	0.010**	0.012***	0.005	0.004	0.002	0.005	0.001	-0.008	0.004	0.013**	0.034***	0.007	0.000	0.024***	0.001	0.028***	0.037***	0.010	0.018**		0.017*	-730	0.1490	11,069
		(0.010)	(0.010)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.009)	(0.009)	(0.005)	(0.002)	(0.011)	(0.007)	(0.016)	(0.012)	(0.000)	(0.011)	(0.008)	(0.010)	(0.018)	(0.008)	(0.012)		(0.014)			
741	Sanitary goods	0.016	0.042***	0.030***	0.024**	0.021***	0.009	-0.001	0.023	0.010	0.038***	0.009	0.014	-0.008	0.015	0.020	0.033**	0.008	0.015	0.020**	0.083***	0.037***	0.036***	0.103***		-1,603	0.1249	11,252
		(0.015)	(0.019)	(0.015)	(0.012)	(0.009)	(0.011)	(0.009)	(0.020)	(0.015)	(0.016)	(0.013)	(0.019)	(0.006)	(0.014)	(0.023)	(0.021)	(0.010)	(0.021)	(0.011)	(0.028)	(0.016)	(0.019)	(0.033)				

Notes: Reported coefficients are marginal effects, i.e., the partial effect of each explanatory dummy variable.
In addition to the variables used in Table 4, the regressions here include dummy variables that take 1 when a household is deemed to have engaged in panic buying of the product in question.

Figure 1. Average daily total expenditures on items covered in INTAGE's SCI

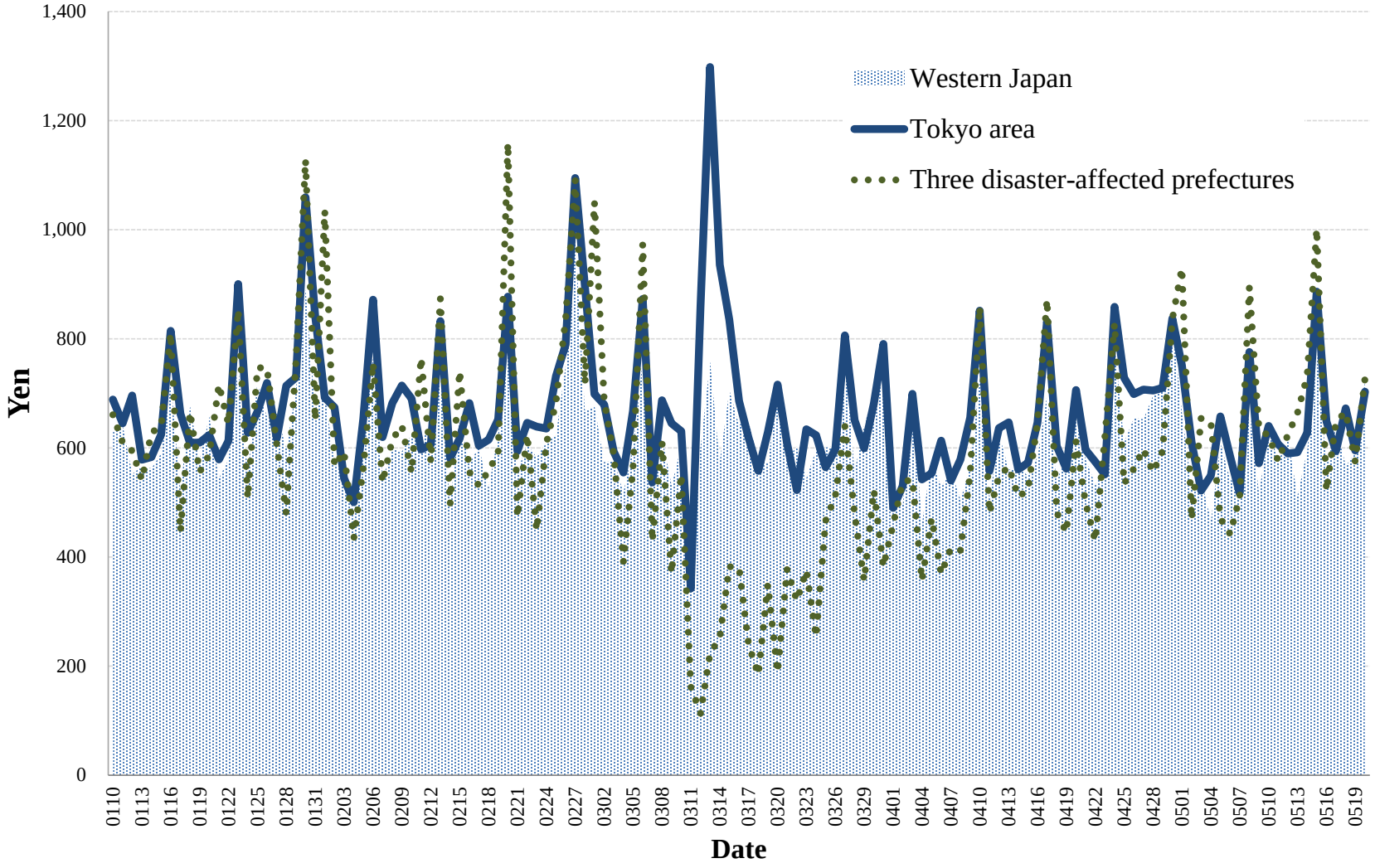
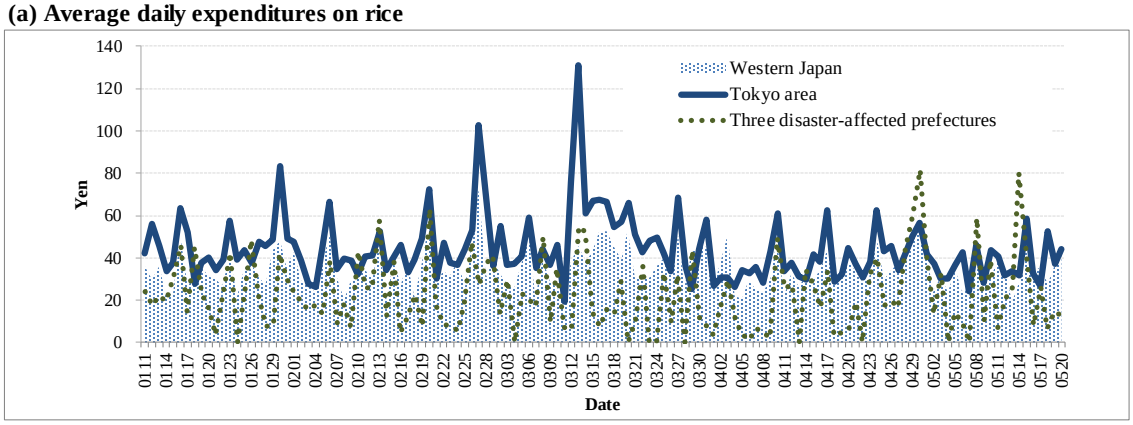
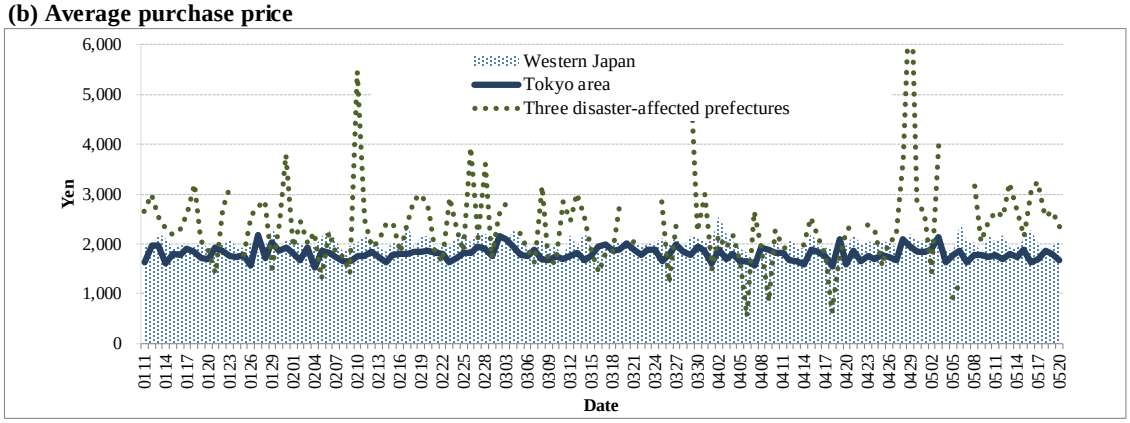


Figure 2. Changes in average daily expenditures on rice and decomposition of changes

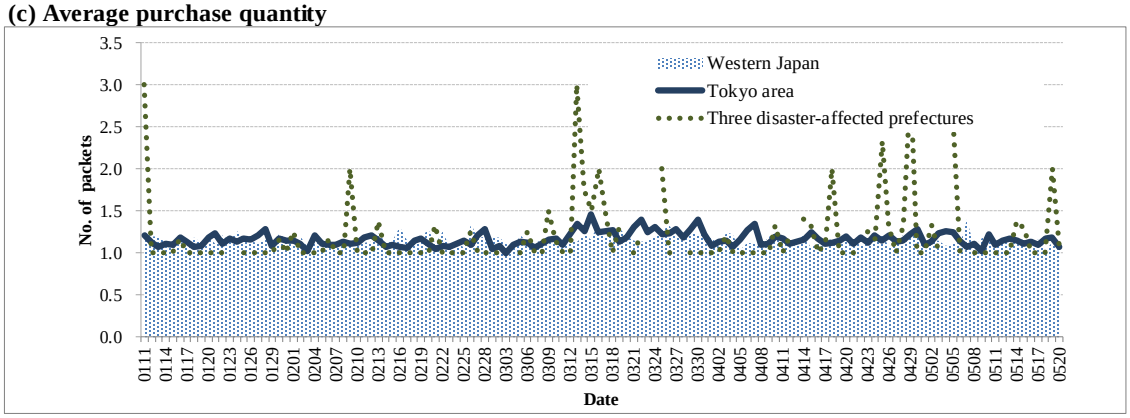
(a) Average daily expenditures on rice



(b) Average purchase price



(c) Average purchase quantity



(d) Share of households that puchased rice on the specified day

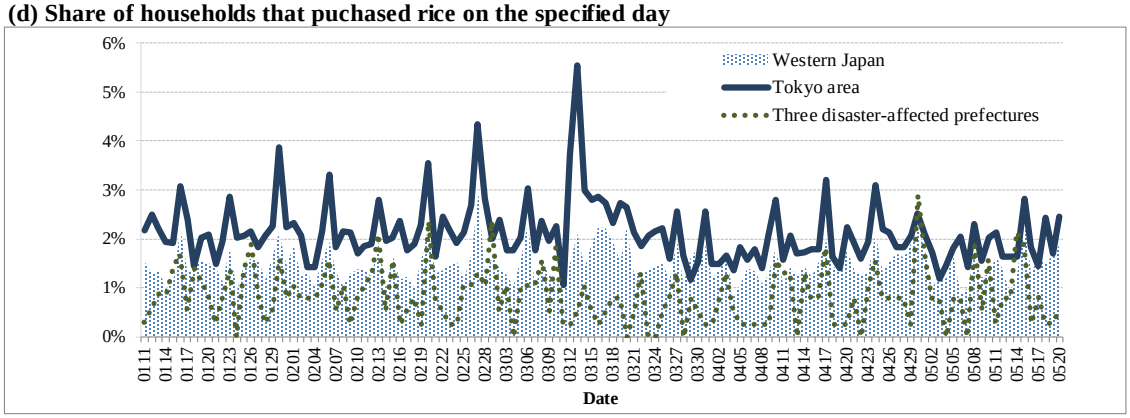
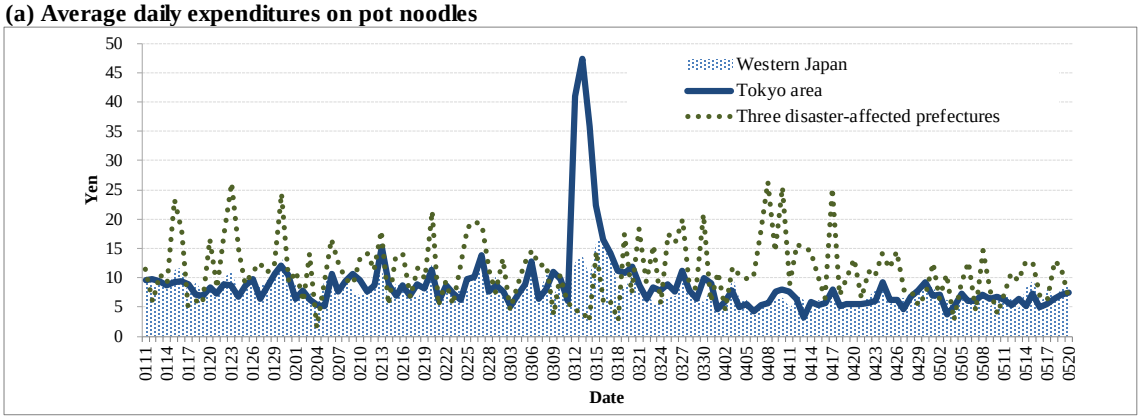
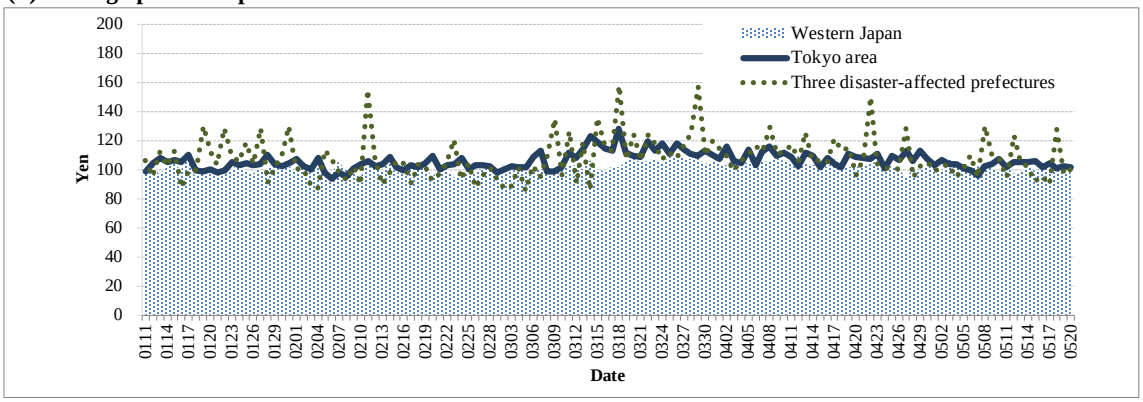


Figure 3. Type I reaction: Expenditures increased with price and/or quantity increases

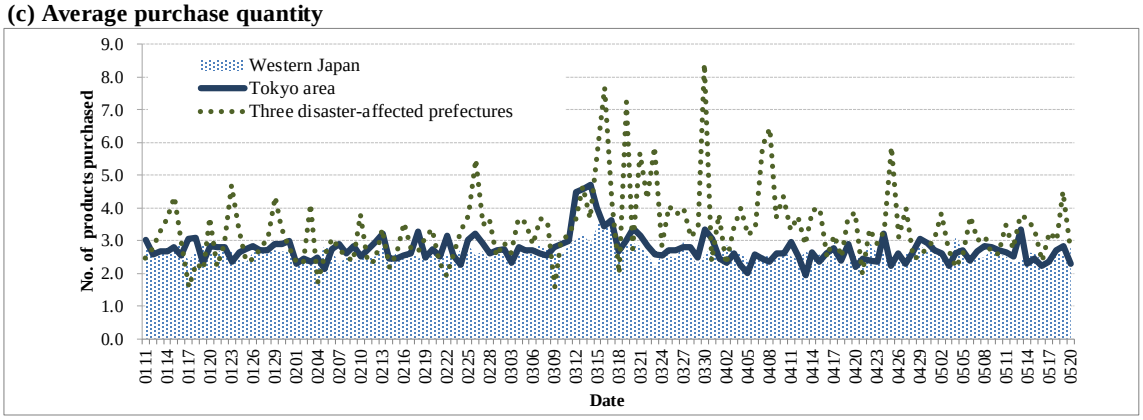
(a) Average daily expenditures on pot noodles



(b) Average purchase price



(c) Average purchase quantity



(d) Share of households that puchased pot noodles on the specified day

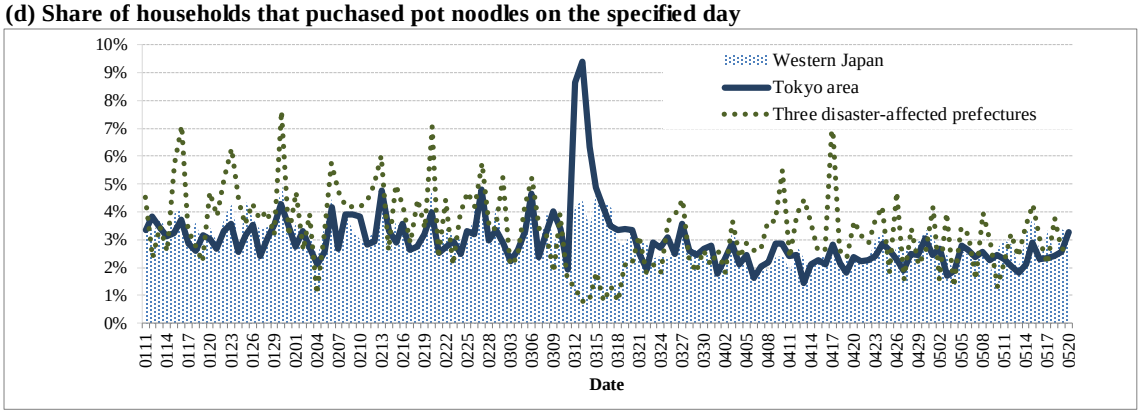
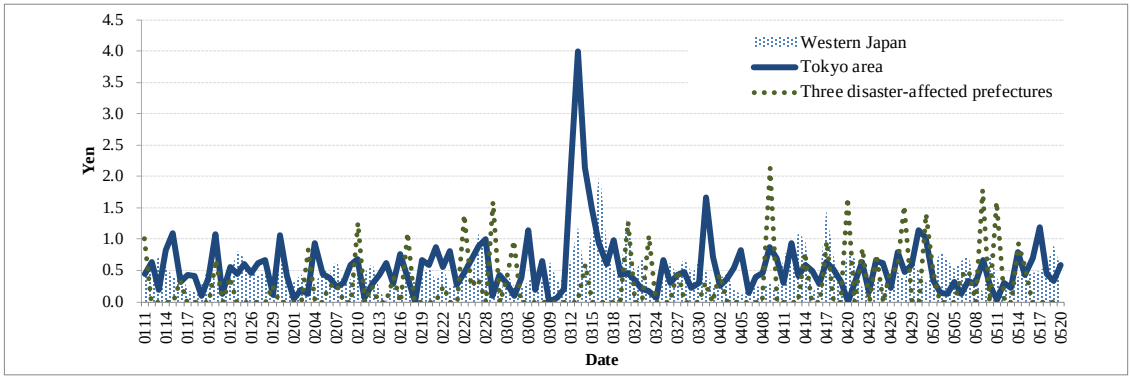
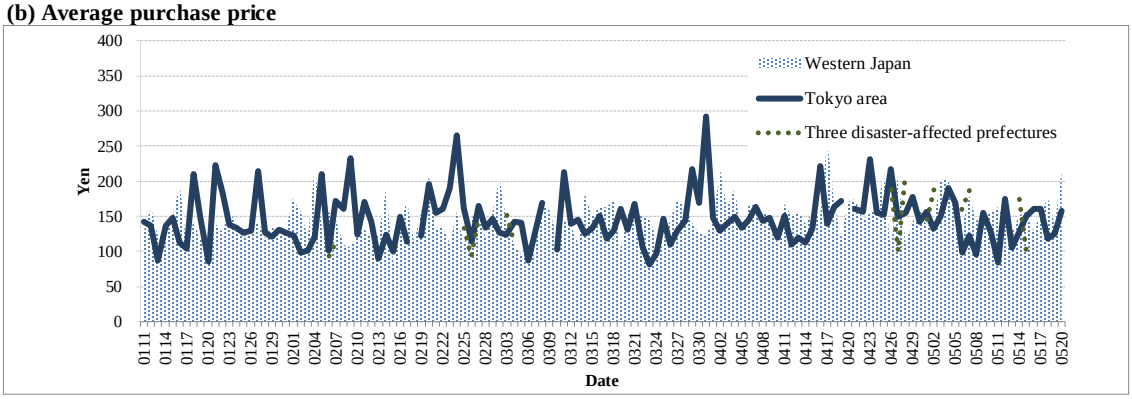


Figure 4. Type II reaction: Expenditures increased without price and quantity increases

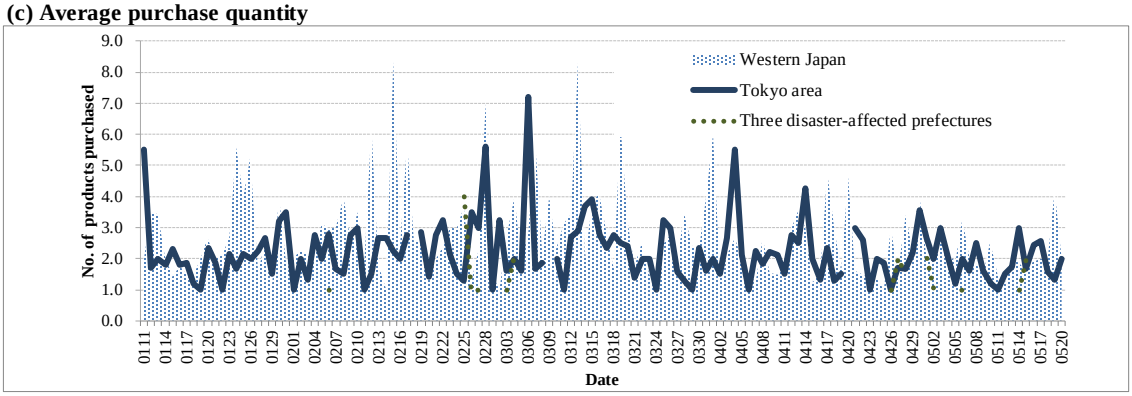
(a) Average daily expenditures on nutritionally balanced instant foods



(b) Average purchase price



(c) Average purchase quantity



(d) Share of households that puchased nutritionally balanced instant foods on the specified day

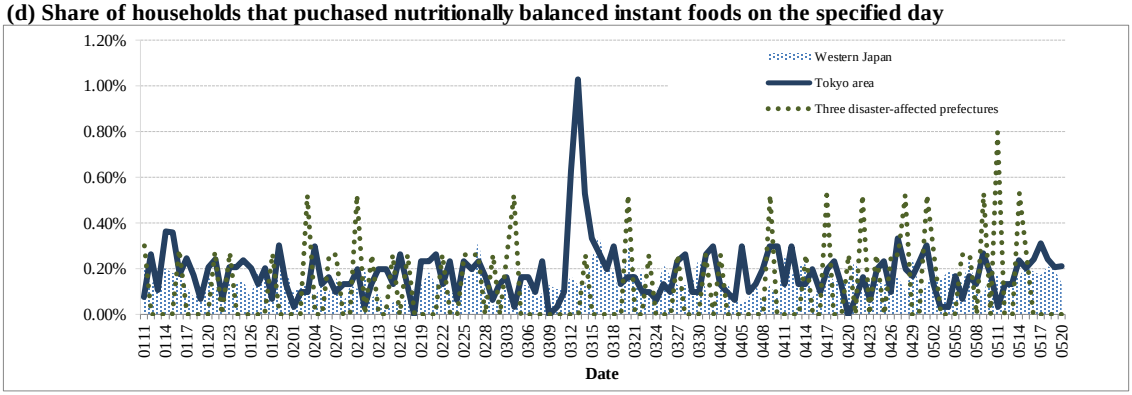
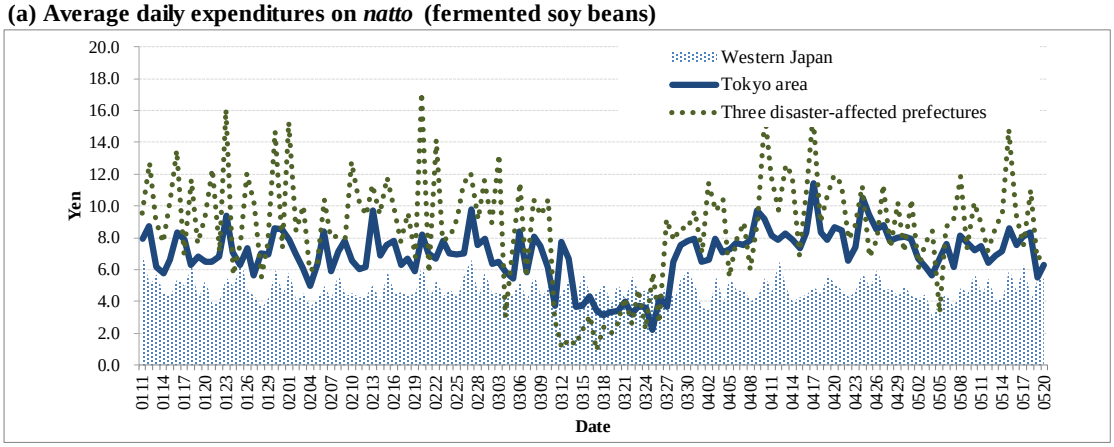
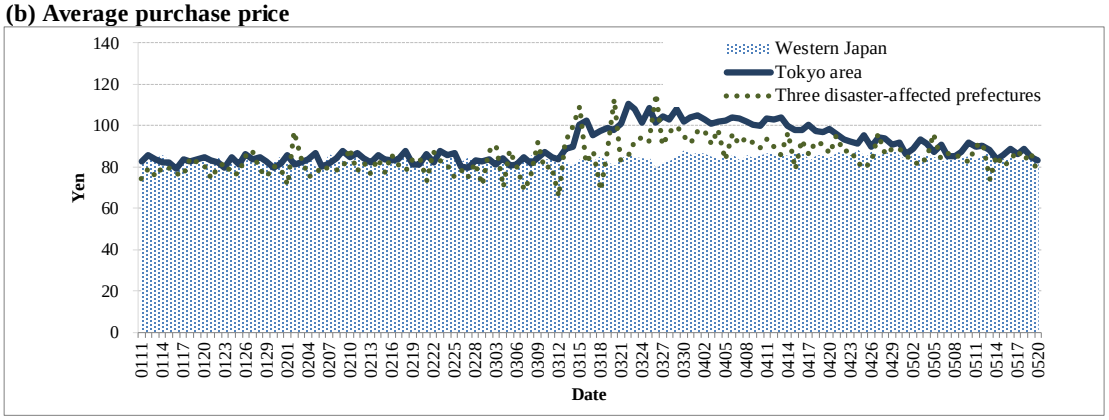


Figure 5. Type III reaction: Expenditures decreased with price and/or quantity increases

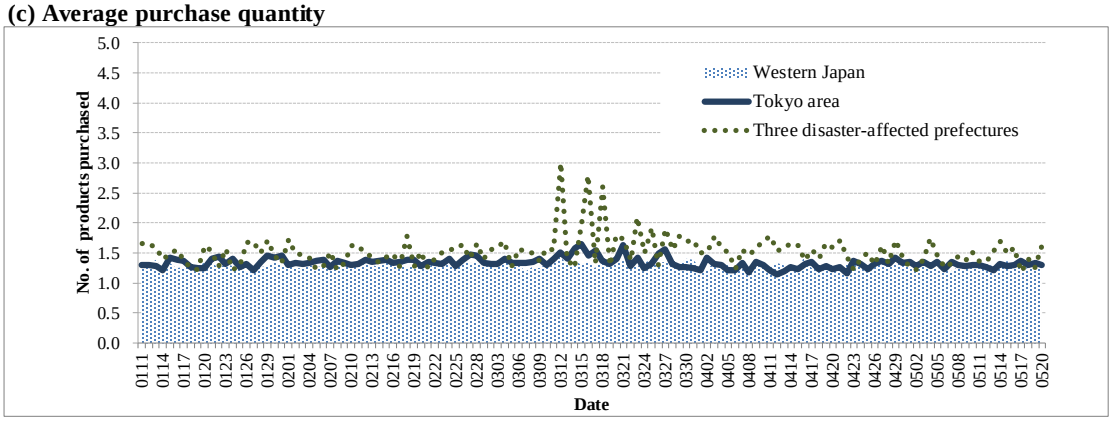
(a) Average daily expenditures on *natto* (fermented soy beans)



(b) Average purchase price



(c) Average purchase quantity



(d) Share of households that puchased *natto* on the specified day

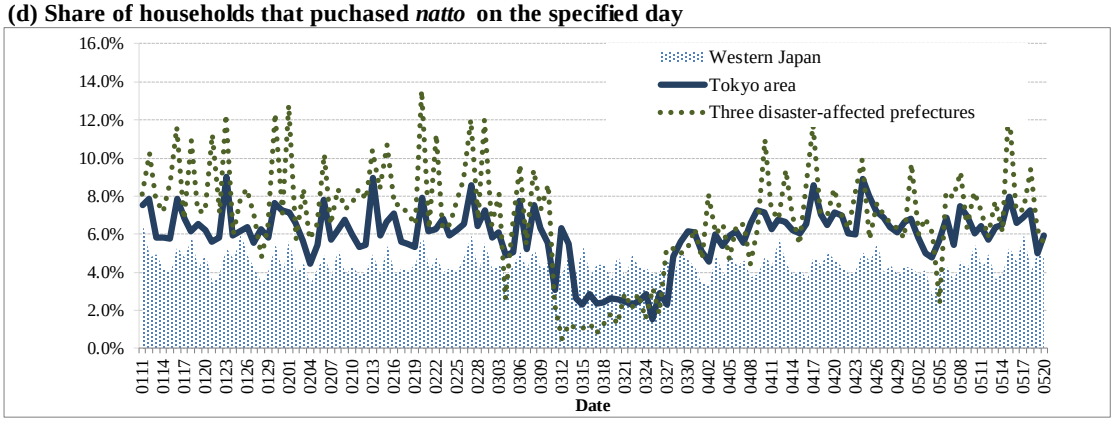
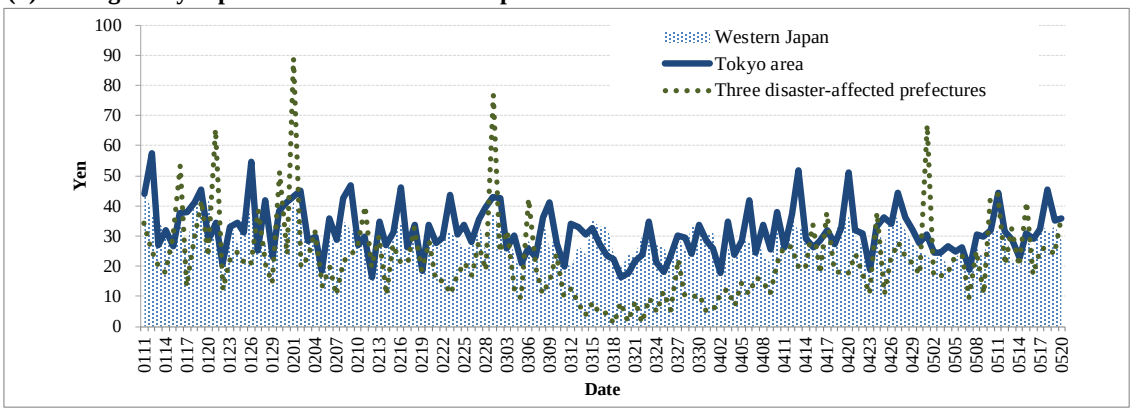
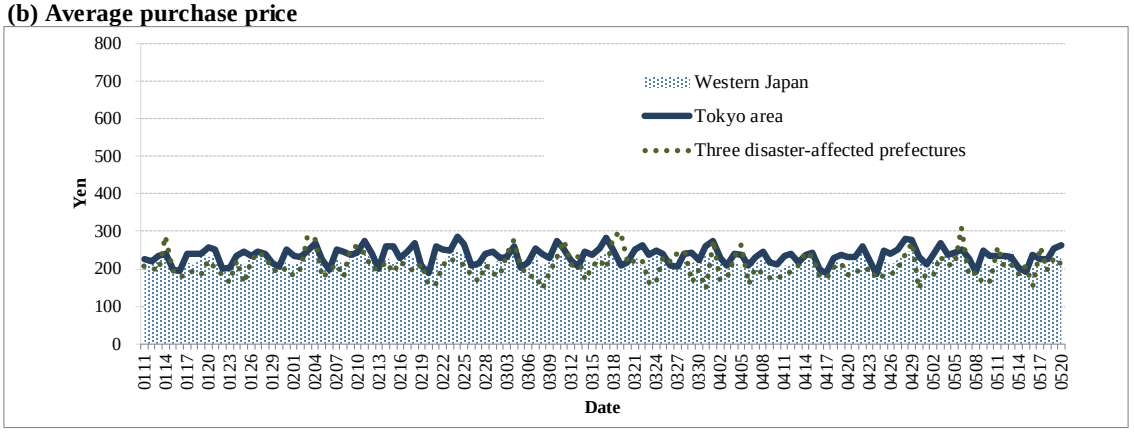


Figure 6. Type IV reaction: Expenditures decreased without price and quantity increases

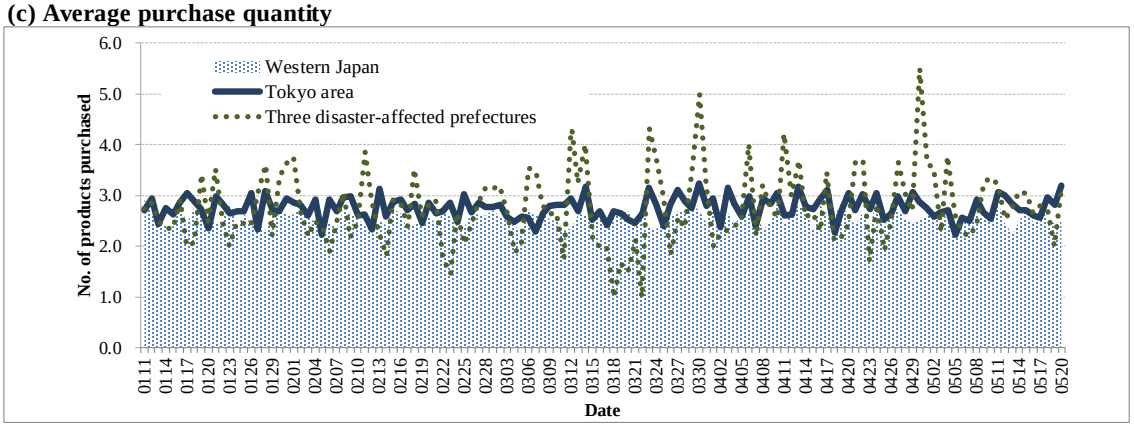
(a) Average daily expenditures on cook-freeze products



(b) Average purchase price



(c) Average purchase quantity



(d) Share of households that puchased cook-freeze products on the specified day

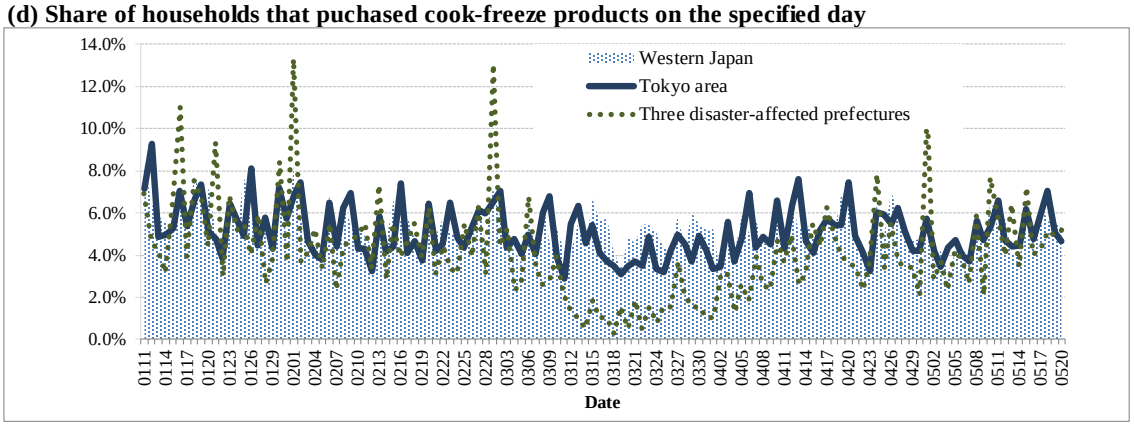
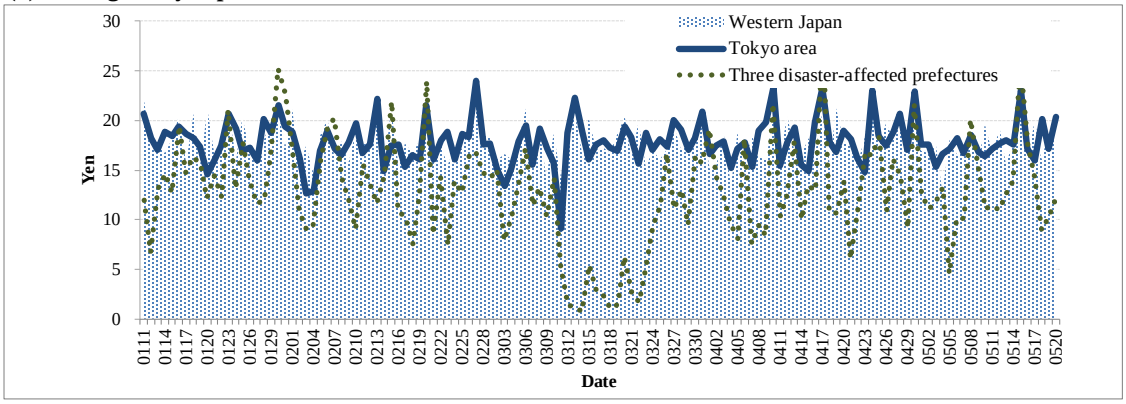
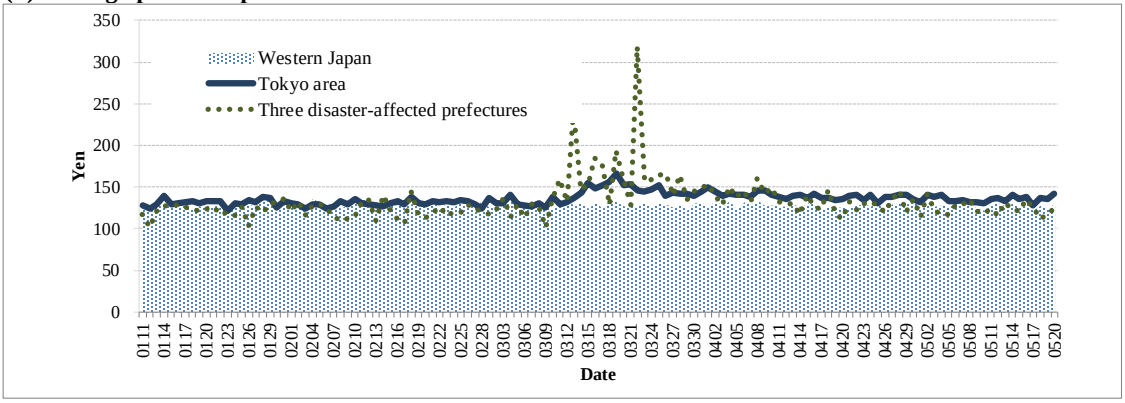


Figure 7. Type V reaction: No clear changes in expenditure but with smaller # of purchasers

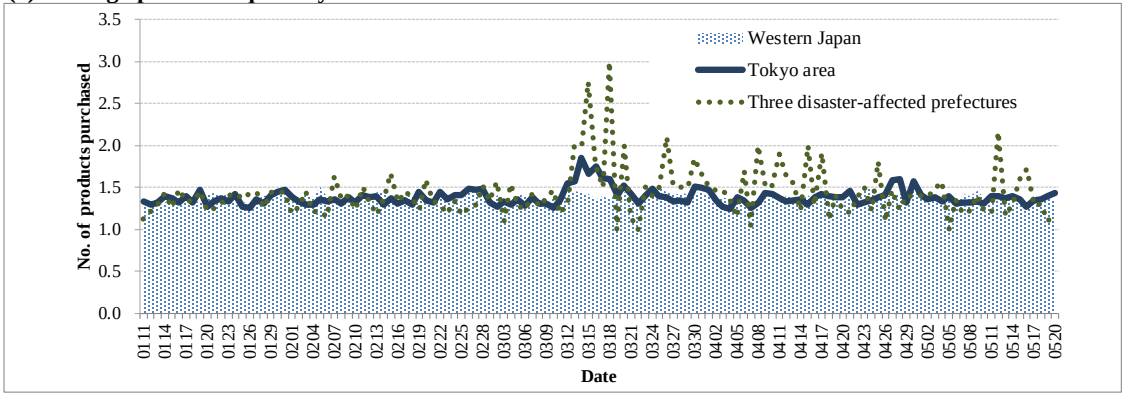
(a) Average daily expenditures on bread



(b) Average purchase price



(c) Average purchase quantity



(d) Share of households that puchased bread on the specified day

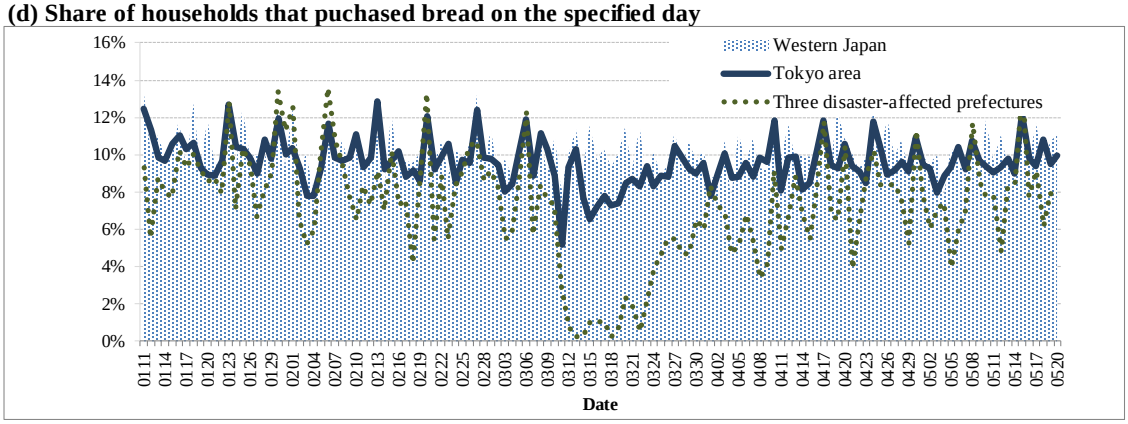
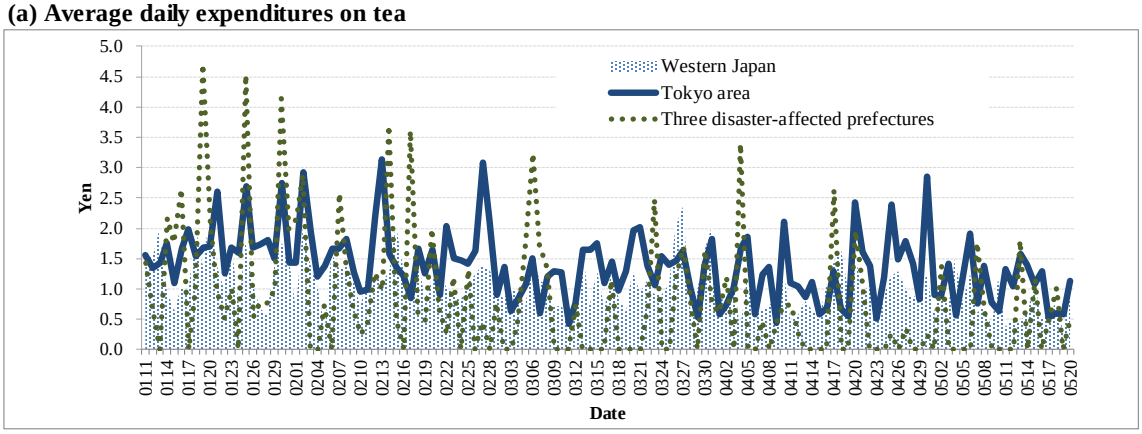
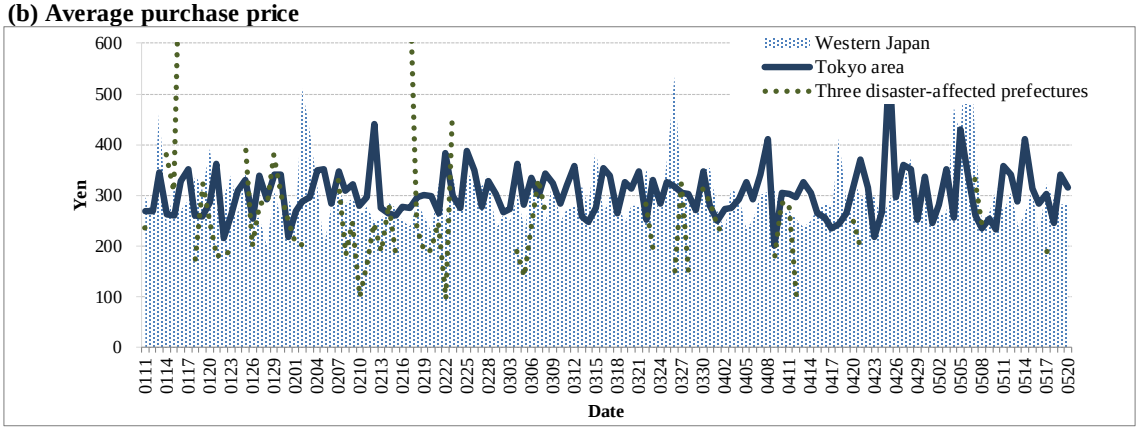


Figure 8. Type VI reaction: No panic or visible impact

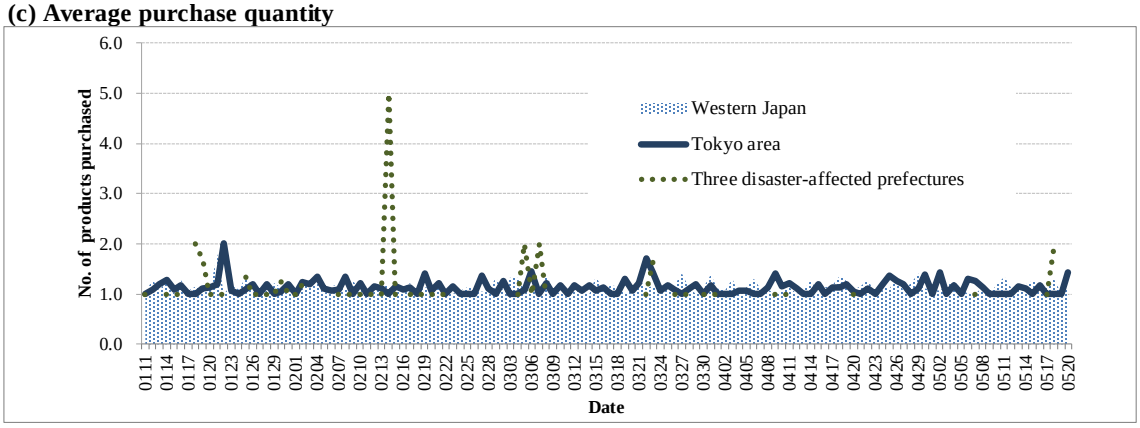
(a) Average daily expenditures on tea



(b) Average purchase price



(c) Average purchase quantity



(d) Share of households that purchased tea on the specified day