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The Effects of Natural Disasters on Prices and Purchasing Behaviors: The Case of the Great East Japan Earthquake*

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The Great East Japan Earthquake in March 2011 not only caused severe damage to the northeastern region, but also affected millions of households beyond the disaster-stricken area. Most notably, the disaster temporarily created large excess demand for many essential goods, resulting in widespread commodity shortages. Did consumers engage in hoarding after the disaster? Did the commodity shortages create any discrepancy between those consumers who were able to stockpile goods and those who could not? In this paper, by using the Great East Japan Earthquake as a natural experiment and taking advantage of unique high-frequency scanner data, we investigate the short-run effects of a major disaster on commodity prices and household purchasing behaviors. We find that commodity prices increased surprisingly little after the disaster, which implies that the excess demand was resolved, not through prices, but through quantity adjustments. Our empirical analysis shows that, while average household expenditure on storable food rose dramatically in response to the disaster, households that had higher opportunity costs of shopping were less likely to stockpile food. Our results indicate substantial heterogeneity in household purchasing behavior in response to a major disaster, which may have important distributional consequences.

Keywords: natural disaster, hoarding, scanner data

JEL classification codes: D12, E21, E31, Q54

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1. Introduction

The powerful earthquake that hit Japan on March 11, 2011, not only devastated towns and villages in the northeastern region, but also disrupted economic activities and affected millions of households in eastern Japan.[1] In particular, the disaster created large temporary excess demand for a number of essential goods far beyond the disaster-stricken area. In the days following the earthquake, the media reported severe shortages of essential goods such as gasoline, rice, and milk in the Tokyo metropolitan area, symbolized by empty shelves and long queues in major supermarkets. As commodity shortages became a national concern, the Minister of Consumer Affairs pleaded for people to refrain from hoarding. To what extent did consumers increase their purchases after the disaster? Did prices increase in response to the excess demand? Under the commodity shortages, how were scarce goods allocated across households? Even though anecdotal evidence abounds, we know very little about the actual movements of prices and expenditure patterns in response to the Great East Japan Earthquake.

The effects of natural disasters on commodity prices have attracted much political attention worldwide. It is often argued that major disasters such as hurricanes, floods, and earthquakes cause a sharp increase in the prices of essential goods and services, much to the detriment of consumers (Sandel 2009; Rotemberg 2011). In the U.S., 31 states have implemented anti-price gouging laws that prohibit firms from raising prices during states of emergency (Davis 2008). These arguments, however, were based largely on anecdotes. We do not know if price gouging is a common response to disasters in the absence of the laws against it, because few empirical studies have explored the impacts of natural disasters on prices.[2]

In this study, we use the Great East Japan Earthquake as a natural experiment in

[1] For an assessment of the damages caused by the Great East Japan Earthquake, see International Recovery Platform (2013) and Schnell and Weinstein (2012).

[2] Many studies have examined economic impacts of natural disasters, but focusing mostly on long-run macroeconomic consequences (see Calvallo and Noy 2011). In a paper most closely related to our study, Sawada and Shimizutani (2008) investigated how households in the disaster-stricken area changed their consumptions after the 1995 Great Kobe Earthquake, using household survey data.

order to investigate the short-run effects of a major disaster on commodity prices and household purchasing behaviors. To implement our analysis, we take advantage of nationally representative high-frequency scanner data to observe daily changes both in commodity-level household expenditure and in store-level commodity prices. Our empirical strategy is to exploit geographical heterogeneity in the seismic impact of the earthquake to identify the effects of the disaster on household purchasing patterns. We also use household survey data to complement our analysis based on scanner data.[3]

The main findings of the paper are as follows. First, in eastern prefectures (excluding the region devastated by the earthquake and subsequent tsunami), average household expenditure on storable food rose sharply in the week following the disaster. However, the increase in food prices in the same week was surprisingly modest, showing little evidence of price gouging. In other words, the surge in expenditure was driven by an increase in the quantities purchased, confirming that consumers did engage in hoarding after the earthquake.

Second, to explain the reasons for hoarding, based on the evidence from household survey data, we hypothesize that the disaster induced a sudden shift in households' perceptions of future uncertainty and raised their optimal inventory level. Consistent with this hypothesis, we find that households that have greater perceived future uncertainty (proxied by the number of major tremors experienced) increased their food expenditure to a greater extent. Further, the greater uncertainty reduced the likelihood of a household going shopping in the week after the disaster (extensive margin), but increased the amount of purchases conditional on going shopping (intensive margin).

Our analysis suggests that the excess demand for essential goods was resolved, not through price mechanisms, but through quantity adjustments in which scarce commodities were rationed across households. Exploring household heterogeneity, we find that households that have high opportunity costs of shopping (measured by having an infant or a

[3] Cavallo et al. (2013) also utilize commodity price data to analyze the effects of 2011 disaster on prices, and found that prices levels are stables after the earthquake. While the data Cavallo et al. (2013) uses based on on-line catalog of a few large general merchandise stores, our paper is based on more than three hundred retail stores all over Japan. Additionally, we use (1) sales amount information, (2) locational information, and (3) bargain household level information.

wife working full-time) did not increase their food expenditure as much as average households did in response to greater uncertainty. In particular, having an infant negatively affected the likelihood of shopping (extensive margin), while having a working wife negatively affected the amount of purchases (intensive margin).

Further, the additional evidence provided by household survey data allow us to argue that households that have higher opportunity costs of shopping were unable to stockpile a sufficient amount of food to prepare for future uncertainty. In other words, the disaster and resulting commodity shortages might have created a measurable discrepancy between those households that were able to stockpile food and those that could not.

The remainder of the paper is structured as follows. In Section 2, we describe the Great East Japan Earthquake and show the geographical distribution of its seismic impact. In Section 3, we present evidence from the household survey data. We introduce the scanner data in Section 4 and document the short-run effects of the disaster on expenditure and prices in Section 5. Using an inventory model of consumer purchase, Section 6 provides an empirical analysis of household purchasing behaviors. Section 7 concludes.

2. The Geography of the Great East Japan Earthquake

A powerful earthquake hit the northeastern region of Japan on Friday, March 11, 2011 at 2:46 pm. According to a seismic intensity measure defined by the Japan Meteorological Agency, Miyagi, the prefecture closest to the epicenter, recorded the maximum intensity of 7 (equivalent to magnitude 9.0 on the Richter scale). In Fukushima, Ibaraki, and Tochigi, the recorded intensity was 6+. Although Tokyo escaped direct damage, its recorded intensity was 5+.

An enormous tsunami followed within 40 minutes of the earthquake, devastating the Pacific coastal areas of the northeastern region. The damage to nuclear power plant in Fukushima resulted in hydrogen explosions on March 12, 14, and 15. To cope with the electric power shortages, the government implemented large-scale rolling blackouts from March 14.

After the initial earthquake on March 11, numerous large aftershocks hit the eastern part of Japan. **Figures 1-(a)** to **1-(c)** show the number of "major tremors," defined as a tremor of seismic intensity greater than 3, in two-week intervals by prefecture.[4] In a tremor of intensity 4, it is described that many people get frightened, some try to escape from danger, and most sleeping people awake. Because we define Week 1 as the first week of January 2011 starting on Friday, the day of the earthquake, March 11 (Friday), corresponds to the first day of Week 11.

Figure 1-(a) shows the number of major tremors in Weeks 8 and 9, representative weeks before the earthquake, which indicates that only two prefectures experienced major tremors. The frequency skyrocketed in Weeks 11 and 12, and prefectures in eastern Japan experienced more than 10 major tremors in these two weeks (see **Figure 1-(b)**). In Iwate, Miyagi, Fukushima, and Ibaraki, more than 20 major tremors were observed in Week 11 alone. By contrast, the western half of Japan experienced no tremors. As shown in **Figure 1-(c)**, many eastern prefectures continued to experience major aftershocks in Weeks 13 and 14.

As shown above, the intensity and frequency of the earthquake and its aftershocks differed substantially across prefectures. In the subsequent analysis, we take advantage of this geographical heterogeneity in identifying the impacts of the disaster on household purchasing behavior. For this purpose, we define three areas, "Directly Affected Area," "East," and "West," as shown in **Figure 2**. "Directly Affected Area" consists of four prefectures, Iwate, Miyagi, Fukushima, and Ibaraki, that received major damages from the earthquakes, tsunami, and nuclear power plant failures. In the following empirical analysis, we exclude "Directly Affected Area" as households in this area were under extreme conditions. "East," our treatment region, consists of seven prefectures that were *not* directly affected by the disaster, but nonetheless experienced at least one major tremor in Weeks 11 and 12 and were subject to rolling blackouts, including Tokyo, Kanagawa, Chiba, Yamanashi, Gunma, Saitama, and Shizuoka. "West," our control region, consists of all

[4] The data are derived from the Japan Meteorological Agency. The weekly frequency of major tremors is reported in **Appendix Table 1**.

prefectures that experienced no major tremor in Weeks 11 and 12, including Fukui, Toyama, Shiga, Mie, and all prefectures to the west of Mie, excluding Okinawa. Regression analyses using prefecture-level data in Section 5 are performed with the data for all prefectures except "Directly Affected Area" and Okinawa.

3. Households' Reactions to the Disaster: Evidence from a Household Survey

To motivate our empirical investigation, we first use data from the Keio Household Panel Survey, conducted in June 2011 covering a nationally representative sample of 2,134 households. The survey asked households to rate the level of "fear and anxiety" they felt about possible aftershocks after the earthquake, using a scale from 0 (="no fear or anxiety") to 100 (="strong fear and anxiety"). As shown in **Figure 3**, there is a strong correlation between the level of anxiety reported by households and the number of major tremors they experienced in Week 11.

The survey also asked households if they tried to "increase the amount of purchase or holding" of water, food, gasoline, and other essential goods after the earthquake. We conduct a probit analysis to investigate the determinants of the willingness to stockpile essential goods. According to **Table 1**, even after controlling for the level of anxiety about possible aftershocks, the number of major tremors in Week 11 has a large and positive effect on a household's willingness to hoard essential goods. It suggests that the number of major tremors can be used as a proxy for household's subjective assessment of future uncertainty. Moreover, such willingness was greater when a household had a young child (aged 0-6) after controlling for household characteristics.

It is important to note, however, that not every household tried to stockpile goods and that not all households that tried were able to obtain the desired amount. **Figures 4(a)-(c)** show the actual experience of households in purchasing essential goods for which severe commodity shortages were reported: gasoline, rice, and instant noodles. The outcomes are classified into 4 categories: (i) could not purchase at all; (ii) deliberately reduced the amount of purchases considering other people; (iii) purchased the usual amount; and (iv) purchased more than usual.

According to **Figures 4**, in western prefectures not hit by major tremors, a large majority of households purchased these goods as usual, although a sizable proportion of households voluntarily restrained their purchases. It was in eastern prefectures where the outcomes diverged substantially across households. In the case of rice, 12% of households could not purchase rice at all in the wake of the disaster, while 8% purchased more rice than usual. Similar polarized outcomes were also observed for gasoline, batteries, instant noodles, bread, and bottled water. This co-existence of households that could not buy at all and those that were able to buy more than usual indicates important household heterogeneity in purchasing outcomes, which needs further analysis.

Finally, note that, even in eastern prefectures, 10% to 20% of households reduced their purchases voluntarily. Together with the households that could not purchase at all, it is not clear if the net effects of the earthquake on household expenditure were positive or negative. Unfortunately, the household survey data are not detailed enough to answer this question.

4. Scanner Data

To provide more in-depth analysis of the impacts of the Great East Japan Earthquake on household purchasing behavior, we introduce two datasets, consumer panel data (hereafter referred to as "homescan") collected by INTAGE, and retail panel data (hereafter referred to as "storescan"), collected by Nikkei Media Marketing. Homescan contains daily shopping information on approximately 12,000 households, randomly selected from all prefectures (except Okinawa) in Japan. The data period is from January 1 to May 31, 2011. Sample households are restricted to married couples. Using a barcode reader, households are asked to scan the barcode of every commodity they purchase, and the scanned data are automatically transmitted to INTAGE's datacenter. In homescan, for every commodity purchased, we can observe: (1) a unique commodity identifier (JAN code), (2) date of purchase, (3) price and quantity, and (4) store name from which the commodity was purchased. The data cover more than 10,000 commodities in 214 commodity categories comprising 146 categories of processed food (e.g., rice, pasta, milk, sugar, condiments, and canned or frozen food) and 68 categories of basic goods (e.g., toiletries, kitchen equipment, and cleaning tools).[5] Fresh food (e.g., meat, fish, and vegetables) without barcodes is excluded. We can also observe basic households characteristics, such as the ages of husband and wife, household income, education, household composition, and the prefecture of residence.

In order to track movements in commodity prices, we need to treat the commodities sold at different stores as non-identical products. When investigating movements of commodity prices, storescan data are more suitable than homescan data. Storescan contains daily transaction data from approximately 300 retail stores located across Japan. The data covers multiple types of retail stores, including general merchandise stores, discount stores, drug stores, and individual stores. In storescan, for each commodity in each store, we can observe (1) JAN code, (2) week of transaction, (3) total quantity sold, (4) total sales, (5) store location, and (6) store type. The data run from the first week of January (Week 1) to the last week of May 2011 (Week 22).[6]

5. Short-run Responses of Expenditure and Prices

5.1 Changes in Household Expenditure After the Disaster

To investigate whether consumers increased their purchases in response to the earthquake, we first look at the movements of household expenditure using daily hoemscan data[7]. In **Figure 5**, we plot average household food expenditure in East and West, as defined in Section 2, from January 8 to May 22. We normalize average expenditure in pre-disaster period (Weeks 2–10) to be unity. Throughout the sample period, we observe a

[5] Abe and Niizeki (2010) provide detailed comparisons between SCI and official consumption surveys (based on diaries) and show that the two datasets exhibit similar age-consumption patterns in most categories.

[6] In the subsequent analyses, we drop Week 1 observations from our sample, as household expenditures deviate from normal patterns during the New Year holidays in Japan.

[7] Storescan data display a similar pattern of changes in sales.

spike in food expenditure on every weekend in both areas, reflecting their weekly shopping patterns. In East, food expenditure fell sharply on March 11, then rose dramatically during the three days after the earthquake, from March 12, Saturday, to March 14, Monday, and then declined to a level below the pre-disaster average for the rest of March. By contrast, in West, food expenditure patterns change little before and after March 11.

Next, in **Figure 6**, using weekly homescan data, we compare the movements of food expenditure in four major prefectures—Hokkaido, Tokyo, Osaka, and Fukuoka (see **Appendix Figure 1** for their locations). For each prefecture, we normalize average expenditure in pre-disaster weeks to be unity. In Tokyo, the expenditure in Week 11 (March 11–17) increased by 27% compared to pre-disaster average and then declined to a level lower than the pre-disaster level for many weeks.[8] Although the expenditure in Hokkaido and Osaka exhibits similar patterns, these changes were modest in comparison to Tokyo. In Fukuoka, which is approximately 1,000 km away from the epicenter, average expenditure did not change in respond to the earthquake.[9] According to **Figures 5** and **6**, household expenditure surged immediately after the disaster in eastern prefectures outside the Directly Affected Area. However, this per se is not an evidence of "hoarding," since a surge in expenditure could have resulted from higher prices. Therefore, it is important to investigate changes in commodity prices.[10]

5.2 Changes in Commodity Prices After the Disaster

When constructing a price index, we need to compute the rate of price change for

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[8] When plotting weekly sales based on storescan, the spike in sales becomes larger than in Figure 6, probably because storescan contains the purchasing behaviors of not only married households, but also single households whose shopping habits might differ considerably.

[9] Although not shown in Figure 6, in the directly affected prefectures such as Iwate and Miyagi, household expenditures fell in Week 11 and declined further in Week 12, showing patterns that were different from the rest of Japan. It suggests that consumers in the directly stricken areas had difficulty in purchasing enough goods to maintain a pre-disaster level of consumption. Owing to a large decline in the number of sample households reporting the data after March 11 in these prefectures, it is difficult to examine their conditions in detail.

[10] In a separate paper, we examine the effects of the Great East Japan Earthquake on commodity prices in detail using homescan and storescan data (Abe, Moriguchi, and Inakura, 2012).

each commodity. That is, for both base and comparison weeks, we need information on commodity prices. Unfortunately, the sample size of homescan was not large enough to compute category-level price index, as we encountered zero transactions for many commodities. Therefore, we used the storescan data to construct a price index at the category level.

Using the storescan data, we computed the Fisher price index as well as GEKS index for food in the four major prefectures, using Week 2 as the base week.[11] As shown in **Figures 7(a) and (b)**, in Tokyo, the food price index increased by 2-3% in Week 11 when average food expenditure rose by 21% according to **Figure 6**. The food price index in Tokyo reached its maximum in Week 12 when the expenditure had already returned to its pre-disaster level. The price index in Tokyo subsequently began to decline, but remained at a slightly higher level than the pre-disaster level during the rest of the sample period. In other areas, there was no clear change in food price levels. In other words, despite the presence of excess demand for a wide range of goods after the disaster, commodity prices responded only slowly and to a small extent.

One thing to be noted is that an increase in price index does not necessarily mean that stores raise their prices. When creating the price index for Week 11, we need transaction records both in Week 11 and the base week (Week 2). In Weeks 11 and 12, due to large supply shocks in various foods, we encountered many missing records in eastern area, so that the price index for Weeks 11 and 12 are based on fewer transaction records than previous weeks such as Week 10. For example, in Week 11 in East, the number of transaction record of natto is about 40% of the preceding weeks. The price change rates are generally very heterogenous. If consumers' shopping behaviors depend on price change rates, it is possible that even though stores do not change the pricing policy after the March 11, the price index exhibit large increase due to surviving biases of the commodities that were available in Weeks 11 and 12.

[11] When creating these price indices, we treat commodities that have the same commodity code but are sold at different stores as different commodities. We follow Ivancic et al. (2011) when creating GEKS and other price indices. See **Appendix Figure 2** for the details of GEKS price index and its relationship with other price indices.

6. The Effects of the Disaster on Household Expenditure Patterns

6.1 A Model of Consumer Purchase with Inventory

In the previous section, we observed that the responses of commodity prices to the March 11 shock were surprisingly modest. In other words, the surge in household expenditures in Week 11 observed in East was primarily due to an increase in the quantity purchased. To better understand household behaviors, we consider the dynamic model of consumer purchase with inventory, developed by Erdem et al. (2003) and Hendel and Nevo (2006a, b). In this model, a good is assumed to be storable and consumers decide the timing and amount of purchases given a stochastic price process. For storable goods, because the time of consumption can differ from the time of purchase, expenditure tends to be concentrated into periods of low prices. A simulation by Erdem et al. (2003) using the data for ketchup shows that consumer expenditure surges during bargain sales and falls in subsequent periods. High-frequency data, such as scanner data, are particularly useful in investigating consumers' stockpiling behavior.

To see if such a model is applicable to our data, we first compare actual household expenditure on storable and non-storable goods. In **Figures 8-(a)** to **8-(f)**, we show the movements of expenditure on six food categories in East in contrast to West. As before, we normalize average expenditure in Weeks 2–10 to be unity. Of these six categories, rice, cereal, and flour are storable, while bread, tofu, and ham are perishable. Compared to West, household expenditure on storable food in East shows a clear *spike* in Week 11 and then declines to a level *lower* than the pre-disaster average. This is consistent with the predictions of the inventory model of consumer purchase described above. For perishable food, the household expenditure in East increases only slightly in Week 11.

In the following analysis, rather than focusing on a specific commodity category and developing a nonlinear dynamic model, we analyze a composite good by aggregating commodity categories and conduct a reduced form analysis.[12] To be concrete, we analyzed three composite goods, namely, all food, staple food (rice, bread, cereal, noodles, flour, pancake mix), and non-staple food. **Table 2** provides descriptive statistics of weekly expenditure on these goods from Week 2 to Week 21. Most notably, average expenditure on staple food in East rose by 61% from 800 yen to 1,287 yen in Week 11 (March 11–17). Not only the level, but also the variance of household expenditure on staple food increased in Week 11, suggesting that the heterogeneity across households increased after the disaster (see **Appendix Table 2**).

Table 3 provides the covariance structures of weekly changes in the expenditure on food, staple food, and non-staple food. For all goods, the autocorrelation with its first lag is approximately -0.5, suggesting strong negative relationships between current and future expenditure growth. Note that, if expenditure follows a random walk, the first autocorrelation should be zero. The negative autocorrelations shown in **Table 3** are similar to those obtained by Erdem et al. (2003) in their model. In the following analysis, we treat these three composite goods as storable goods and adopt a home inventory model.

6.2 Estimating the Effects of the Disaster on Stockpiling Behavior

Previous research on the determinants of optimal home inventory (Erdem et al., 2003; Hendel and Nevo, 2006a, b) has focused on the effects of uncertainty about future prices. In the case of the Great East Japan Earthquake, however, we expect sudden and more fundamental shifts in households' perceptions of future uncertainty. In the days that followed March 11, it must be noted that: (1) numerous aftershocks were raising the fear of another major earthquake; (2) nuclear power plant accidents were still unfolding with potential radiation contamination of water and food; (3) to prevent major electric power failures, the government improvised a daily schedule of rolling blackouts, creating much

[12] Existing studies, such as Erdem et al. (2003) and Hendel and Nevo (2006b), focus on a few categories, such as ketchup or detergent and estimate dynamic consumer choice using a nonlinear model. To implement this, however, we need information on the dynamic processes of multiple commodity prices and unobservable preference shocks.

confusion; and (4) the shortages of essential goods were widely reported with a rumor of people engaging in "hoarding." We assume that all of these factors influenced consumers' subjective assessments of future uncertainty, not only in terms of prices, but also in terms of the availability and safety of food, which led them to re-optimize inventory levels to maintain a sufficient level of future consumption.

Motivated by the evidence from the household survey data, we hypothesize that a household's subjective assessment of future uncertainty increases with the number of major aftershocks experienced, and use prefecture-level variations in the weekly frequency of major tremors to identify the impacts of the disaster on stockpiling behavior. It is important to emphasize that in the subsequent regression analyses, we drop observations after Week 11. As we have shown, many eastern prefectures continued to experience major aftershocks in Week 12 and beyond (see **Figure 1-(c)**), which in itself should further increase household expenditure in these prefectures. At the same time, however, there are strong negative autocorrelations in expenditure growth (see **Table 3**) indicating that those households that increased their expenditure in Week 11 should reduce their expenditure in Week 12. As a result, without knowing the level of home inventory in Week 11, we cannot identify the effects of major tremors in Week 12. As we drop the observations in Weeks 12–21 from the following analyses, we focus on the effects of the major tremors on the expenditure increase in Week 11.

As the base specification, we estimate the following equation regarding the change in weekly expenditure, ΔE_{it}, of household *i* in week *t* (t = 4, 5,…, 11):

$$\Delta E_{it} = c^E + \alpha_1^E Tremors_{it} + \beta^E X_{it} + T_t + \varepsilon_{it}^E \qquad (1)$$

where *c* is a constant, $Tremors_{it}$ is the square root of the number of major tremors household *i* experienced in week *t*; X_{it} is a vector of household characteristics (household income, wife's age and work status, household size and composition); and T_t is the time effects captured by week dummies.

Next, we investigate the heterogeneity across households in purchasing behavior after the disaster. Recall that the price index did not increase much in Week 11. This suggests that the temporary excess demand induced by the disaster was resolved mainly through quantity adjustments, most notably, "rationing by queuing" and "quantity restrictions."[13] Under these allocation mechanisms, we expect households that have lower opportunity costs of shopping can purchase a higher quantity of scarce commodities (by queuing or visiting a variety of stores). In a recent study, Aguiar and Hurst (2007) show that the opportunity costs of shopping play a major role in optimal consumption decisions by using the husband's retirement status as a proxy for opportunity costs. In our analysis, we focus on two variables: the presence of an infant and the wife's work status. We postulate households that have an infant (aged 0–3) have higher opportunity costs of shopping than those without. Similarly, we postulate that households in which a wife works *full-time* have higher opportunity costs of shopping than those in which a wife is not working or works part-time.[14]

To further investigate household purchasing behavior, we introduce two additional variables: shopping frequency and shopping interval. Shopping frequency is the number of purchases a household makes in a week (see **Appendix Table 3** for the descriptive statistics). Because we observe only the date of purchase and name of store from which the purchase was made, we compute shopping frequency assuming that a household makes purchases from the same store only once a day. Note that if a household visited a store but did not make any purchases (this may happen when goods are sold out), such visits are not counted as shopping.

Shopping interval is measured in weeks and captures the number of weeks that passed since the last purchase (see **Appendix Table 4** for the descriptive statistics). If a household purchases food every week, the interval is one. In general, for storable food such as rice and pasta, many households do not make purchases every week. A longer shopping interval is associated with a higher likelihood of purchase in the current week. As such, it is important to control for shopping interval when analyzing the effects of the disaster on subsequent shopping behavior.

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[13] For recent empirical analysis of rationing by queuing, see Batabyal and DeAngelo (2012).

[14] According to the 2005 Census data, 50% of married women under the age of 35 in Japan do not have any paid job—a remarkably high number for developed countries.

To investigate household heterogeneity in response to the disaster, we estimate the following equation:

$$\Delta E_{it} = c^E + \left(\alpha_1^E + \alpha_2^E Infant_i + \alpha_3^E Fulltime_i + \alpha_4^E Shopping_{it}\right) \times Tremors_{it} + \beta^E X_{it} + T_t + \varepsilon_{it}^E, \qquad (2)$$

where $Infant_i$ and $Fulltime_i$ are dummy variables that indicate the presence of infant and a wife working full-time in household *i*, respectively, and $Shopping_{it}$ is the number of purchases (shopping trips) made by household *i* in week *t*. We interact each of these variables with the number of tremors experienced by household *i*.

Table 4 presents the descriptive statistics of the variables used in the regressions. In our sample, 12.5% of households have an infant and 14.5% of households have a wife working full-time. The average household purchases foods 3.0 times per week, while the average shopping interval for food is 1.36 weeks or 9.5 days (note that if all households make purchases every week, the interval would be 1.0 week). It is important to note that the standard deviations for both shopping frequency and shopping interval are large, indicating that there is great heterogeneity across households in their purchasing patterns.

The estimation results for the three goods (all foods, staple food, non-staple food) are reported in **Table 5**. In almost all specifications, the number of major tremors has large, positive, and significant effects on the changes in expenditure. (The effects for non-staple food are smaller and less significant than those for staple food.) That is, households who experienced more major aftershocks in Week 11 stockpiled more food.

Upon examining the effects of household characteristics in specification (10), the wife's work status and presence of an infant have little effect on the expenditure for staple goods in the pre-disaster weeks. The coefficients of the interaction terms, *Infant*×*Tremors* and *Fulltime*×*Tremors*, however, are large, negative and significant. It shows that, compared to the average household that increased their weekly expenditure on staple food by 66 yen in response to major tremors, the households with a working wife and those with an infant increased their expenditure only by 30 yen and 39 yen, respectively, which is consistent with our hypothesis that their opportunity costs of shopping are higher.

The coefficient of *Fulltime*×*Tremors* is smaller in specification (10) compared with specification (9), suggesting that the households with a working wife did not increase their expenditure on staple food in Week 11 as much partly because they had lower frequency of shopping. The same is true for non-staple food. For the households with an infant, by contrast, the results for staple and non-staple food are qualitatively different.

6.3 Extensive and Intensive Margins of Purchasing Behaviors

To understand a mechanism behind the changes in household expenditure, we decompose them into extensive and intensive margins. Consider a household that usually purchases rice every other week. If the household purchased rice in Week 10, the next purchase would not occur in Week 11. If the disaster suddenly raised the desired level of rice inventory, however, the household would purchase rice in Week 11. In this case, an increase in expenditure occurs through a change in the extensive margin. By contrast, consider a household that usually purchases rice every week. Then, to raise the level of rice inventory after the disaster, the household would increase the weekly expenditure in Week 11. In this case, an increase in the expenditure occurs through a change in the intensive margin.

For the extensive margin, we estimate the following equation:

$$S_{it} = c^S + \left(\alpha_1^S + \alpha_2^S Infant_i + \alpha_3^S Fulltime_i + \alpha_4^S Interval_{it}\right) \times Tremors_{it} \\ + \beta^S X_{it} + \delta^S Interval_{it} + H_i + T_t + \varepsilon_{it}^S, \tag{3}$$

where S_{it} is the extensive margin defined by an indicator variable that takes unity when positive expenditure is observed for household i in week t; $Interval_{it}$ is shopping interval defined by the number of weeks since the last purchase made for household i in week t; and H_i is household fixed effects.[15] Shopping frequency is not included because it perfectly predicts the dependent variable (i.e., extensive margin).

The intensive margin is defined by:

[15] We use a linear probability model with household fixed effects rather than a probit model.

$$G_{it} = \frac{E_{it} - E_{ik<11}\left[E_{ik}\left|S_{ik} = 1\right.\right]}{E_{ik<11}\left[E_{ik}\left|S_{ik} = 1\right.\right]},$$

where E_{it} is expenditure and S_{it} is the extensive margin of household *i* in week *t*. The denominator is average weekly expenditure conditional on positive expenditure during pre-disaster weeks (Weeks 4–10). The numerator is the gap between the actual expenditure of household *i* in week *t* and the conditional average. For the intensive margin, we estimate the following equation:

$$\begin{aligned} G_{it} &= c^G + \left(\alpha_1^G + \alpha_2^G Infant_i + \alpha_3^G Fulltime_i + \alpha_4^G Shopping_{it} + \alpha_5^G Interval_{it}\right) \times Tremors_{it} \\ &+ \beta^G X_{it} + \gamma^G Shopping_{it} + \delta^G Interval_{it} + T_t + \varepsilon_{it}^G, \end{aligned} \quad (4)$$

where $Interval_{it}$ is shopping interval defied above and $Shopping_{it}$ is shopping frequency defined by the number of purchases made by household *i* in week *t*.

The descriptive statistics of the extensive and intensive margins are provided in **Appendix Tables 5** and **6**. With respect to the extensive margin, in East, observe that the ratio of households making any purchase of foods was 80% in Week 10 and declined to 77% in Week 11, while no such decline was observed in West. With respect to intensive margins, for staple food in Week 11, we observe not only a large spike in East but also a smaller but clear increase in West.

Table 6 presents the estimation results for the extensive margin. In all specifications, the number of major tremors has a *negative* effect on the extensive margin[16]. It implies that the disaster reduced the probability of households making any purchase. According to specification (3), for staple food, an increase in the square root of tremors by one reduces the probability of shopping in Week 11 by 1.2%, while an increase in shopping interval by one week increases the probability of shopping by 7.2%. When the interaction term *Interval*×*Tremors* is added in specification (4), its coefficient is negative and significant. This means that the disaster dampened the positive effects of shopping interval on the probability of shopping.

[16] Although the effect of tremors turns positive in specifications (4) and (10), it does not imply that the disaster raised the probability of shopping. Rather, the negative effect of the interaction term *Interval*×*Tremors* dominates the effect of tremors, as the minimum value of shopping interval is one.

When we examine the household characteristics in specifications (7)–(12), the coefficient of *Infant×Tremors* is negative and significant in most specifications, while the coefficient of *Fulltime×Tremors* is not significantly different from zero in all specifications.[17] In other words, the households with infant exhibited a greater reduction in the probability of shopping for both staple and non-staple food in Week 11 in response to the disaster. To summarize, the disaster reduced the likelihood of making any purchase in Week 11 for all households on average, and this effect was stronger for the households with an infant (but not for the households with a working wife).

The estimation results for the intensive margin are reported in **Table 7**. In sharp contrast to the extensive margins, in all specifications, the effects of the number of major tremors on the intensive margin are *positive*, large, and significant. In other words, conditional on households making a purchase in Week 11, expenditure was higher for the households experiencing major tremors. In specification (3), for staple food, an increase in the square root of tremors by one increases the expenditure in Week 11 by 9.6%, while an increase in shopping interval by one week increases the probability of shopping by 2.7%.

For all foods in specifications (7) and (8), the coefficient of *Infant×Tremors* is positive and significant, while that of *Fulltime×Tremors* is negative and significant. When we decompose foods into staple and non-staple food, the coefficient of *Infant×Tremors* is effectively zero for staple food (see specifications (9) and (10)), but positive and significant for non-staple food (see specifications (11) and (12)). By contrast, the coefficients of *Fulltime×Tremors* are negative but not significant for both staple and non-staple food. These results suggest that, in response to greater uncertainty, conditional on households making a purchase, those that have an infant increased expenditure on non-staple food (but not on staple food) more than average households, whereas those that have a working wife increased their food expenditure to a smaller degree than average households.

To summarize our regression results, the increase in uncertainty has *positive* impacts on the change in average expenditure in Week 11 and on the expenditure

[17] Note that, because we include household fixed effects, the effects of household characteristics are identified only through the interaction terms that are time variable.

conditional on making a purchase, but negative impacts on the probability of making a purchase in Week 11. Together, these findings imply that after the disaster some households did not make any purchase of food at all, while other households went shopping and purchased more food than they did in the pre-disaster period.

Upon looking into household heterogeneity in response to the disaster, we find that, for the households with a wife working full-time, their probability of purchasing any food in Week 11 was no lower than the average households, but conditional of purchasing, the increases in their food expenditure were smaller in general. For the households with an infant, they were more likely to make no purchase in Week 11, but conditional on purchasing, their expenditure on non-staple food was higher.

Unfortunately, in the homescan data, we cannot distinguish those households that made no purchases because they *did not need to* from those that *could not go shopping* (because of higher opportunity costs) or those that went shopping but *could not find the desired goods* (because they were sold out). Our analysis of the household survey data in Section 3, however, shows that households that experienced a greater number of major tremors showed a higher willingness to stockpile essential goods and that households that had a small child displayed an even greater willingness to increase their purchase levels (**Table 1**). The same data also indicate that a nontrivial proportion of households in eastern prefectures could not purchase a desired good at all. Taken together, our results strongly indicate that, under the commodity shortages induced by the disaster, households that have higher opportunity costs of shopping, such as those with an infant or a working wife, were more likely to be "rationed out" and could not stockpile essential goods despite their willingness to do so.

7. Concluding Remarks

In this paper, using the Great East Japan Earthquake as a natural experiment and taking advantage of unique high-frequency scanner data, we investigate the short-run effects of a major disaster on commodity prices and household purchasing behaviors. We find that commodity prices increased surprisingly little after the disaster, which implies that excess demand was resolved, not through prices, but mainly through quantity adjustments. Our empirical analyses indicate that, while average household expenditure on storable food rose dramatically in response to the disaster, households that had high opportunity costs of shopping were more likely to be “rationed out” and could not stockpile food to their desired levels to prepare for future uncertainty. Our results indicate substantial household heterogeneity in response to a major disaster, which may have important distributional consequences.

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Table 1: Probit Analysis of Household's Willingness to Stockpile

	(1)	(2)
Anxiety Level (0-100)		
10-20	0.0565	0.0568
	(0.0864)	(0.0867)
30-40	0.0295	0.0295
	(0.0799)	(0.0802)
50-60	0.155*	0.156*
	(0.0826)	(0.0833)
70-80	0.171**	0.173**
	(0.0758)	(0.0763)
90-100	0.230***	0.231***
	(0.0753)	(0.0758)
No. of Aftershocks Experienced		
1-9	0.149***	0.148***
	(0.0250)	(0.0250)
10-19	0.233***	0.231***
	(0.0405)	(0.0405)
20 or More	0.278***	0.276***
	(0.0678)	(0.0679)
Infant (age 0-2)	0.0253	
	(0.0669)	
Pre-school Child (age 0-6)		0.0839*
		(0.0432)
Family Size	-0.00553	-0.00749
	(0.00830)	(0.00836)
No. of Households	1,579	1,579
Pseudo R-squared	0.0866	0.0894

Notes: *** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses.

Marginal effects of Probit are reported.

The sample consists of 1,579 married households in the Keio Household Panel Survey.

The dependent variable is a dummy variable that takes unity if a household tried to increase the amount of purchase of essential goods (e.g., water, foods, gasoline) after the earthquake.

Anxiety Level 0 corresponds to "no fear or anxiety" and 100 corresponds to "strong fear and anxiety".

The number of aftershocks experienced is the number of aftershocks in Week 11 in a household's prefecture of residence.

The ommited category for Anxiety Level is 0-10.

The ommited category for the number of aftershocks experienced is 0.

The age and education of male household head and the employment status of female spouse are controlled (results not reported).

Table 2: Descriptive Statistics of Weekly Expenditures on Foods

Week	East							West							All						
	N	Mean			Std.dev			N	Mean			Std.dev			N	Mean			Std.dev		
		Foods	Staple	Else	Foods	Staple	Else		Foods	Staple	Else	Food	Staple	Else		Foods	Staple	Else	Food	Staple	Else
2	3853	3504	726	2777	3291	1127	2681	5063	3228	667	2561	3074	1011	2530	11312	3336	689	2647	3149	1055	2583
3	3853	3580	729	2852	3340	1050	2767	5063	3476	697	2779	3174	1048	2611	11312	3533	716	2816	3271	1082	2696
4	3853	3716	744	2972	3582	1099	2978	5063	3583	712	2871	3415	1016	2856	11312	3644	726	2918	3458	1066	2883
5	3853	4189	838	3351	3994	1240	3294	5063	3818	754	3065	3499	1077	2914	11312	3967	789	3178	3725	1179	3069
6	3853	3780	760	3020	3620	1056	3028	5063	3438	706	2731	3251	1055	2677	11312	3568	720	2848	3398	1057	2817
7	3853	3687	773	2915	3532	1134	2878	5063	3512	711	2801	3409	1189	2793	11312	3606	743	2863	3459	1169	2825
8	3853	3719	785	2933	3535	1133	2868	5063	3510	733	2778	3269	1111	2696	11312	3590	751	2839	3405	1141	2777
9	3853	4325	892	3433	4064	1292	3345	5063	3987	798	3189	3707	1204	3067	11312	4100	830	3270	3869	1285	3196
10	3853	3672	800	2872	3471	1164	2800	5063	3382	712	2671	3245	1072	2610	11312	3485	737	2749	3317	1097	2691
11	3853	4472	1287	3184	4492	1780	3256	5063	3472	793	2679	3318	1139	2672	11312	3922	1013	2908	3913	1533	2955
12	3853	3477	880	2598	3762	1458	2860	5063	3366	730	2636	3341	1103	2738	11312	3391	785	2606	3502	1275	2767
13	3853	3790	826	2964	4143	1453	3299	5063	3736	774	2963	3761	1267	3057	11312	3741	790	2950	3920	1334	3156
14	3853	3236	649	2587	3353	1007	2773	5063	3129	655	2474	3213	1198	2600	11312	3170	650	2519	3268	1137	2670
15	3853	3640	740	2900	3539	1127	2881	5063	3309	678	2631	3213	1062	2644	11312	3445	702	2743	3359	1153	2727
16	3853	3595	749	2846	3463	1131	2786	5063	3441	709	2732	3214	1017	2665	11312	3496	721	2775	3310	1075	2708
17	3853	3799	784	3015	3757	1154	3074	5063	3698	759	2939	3473	1154	2863	11312	3716	761	2955	3596	1169	2959
18	3853	3738	764	2975	3961	1255	3278	5063	3512	731	2780	3653	1163	2983	11312	3610	740	2871	3793	1198	3119
19	3853	3483	703	2780	3473	1044	2844	5063	3356	690	2665	3315	1042	2731	11312	3396	692	2704	3346	1062	2742
20	3853	3681	750	2931	3446	1115	2815	5063	3419	707	2712	3246	1016	2683	11312	3514	726	2788	3334	1142	2716
21	3853	4019	828	3191	3857	1153	3149	5063	3767	772	2995	3472	1095	2877	11312	3827	786	3041	3608	1140	2961
Total	77060	3755	800	2955	3707	1218	2997	101260	3507	724	2783	3374	1105	2773	226240	3603	753	2849	3514	1175	2861

Note: Staple foods include rice, bread, noodle, cereal, flour, and pancake mix.

The 3/11 is the first day of Week 11.

See the notes in Figure 2 for the definition of East and West.

Table 3: Covariance Structure of Change Rate of Expenditures in Weeks 2-10 before the Earthquake

Foods

	dln(Expense)	dln(Expense)[-1]	dln(Expense)[-2]	dln(Expense)[-3]	dln(Expense)[-4]	dln(Expense)[-5]
dln(Expense)	0.6525	-0.3491	0.0219	-0.0118	0.0208	-0.0046
dln(Expense)[-1]	-0.5402	0.6399	-0.3415	0.0309	-0.0061	0.0077
dln(Expense)[-2]	0.0338	-0.5339	0.6393	-0.3577	0.0265	0.0032
dln(Expense)[-3]	-0.0181	0.0478	-0.5546	0.6508	-0.3516	0.0200
dln(Expense)[-4]	0.0320	-0.0094	0.0412	-0.5418	0.6471	-0.3440
dln(Expense)[-5]	-0.0072	0.0120	0.0049	0.0310	-0.5336	0.6421

Number of observarions = 16726

Staple Foods

	dln(Expense)	dln(Expense)[-1]	dln(Expense)[-2]	dln(Expense)[-3]	dln(Expense)[-4]	dln(Expense)[-5]
dln(Expense)	1.3806	-0.7584	0.0671	-0.0452	0.0722	-0.0296
dln(Expense)[-1]	-0.5532	1.3613	-0.7372	0.0755	-0.0328	0.0396
dln(Expense)[-2]	0.0494	-0.5463	1.3374	-0.7458	0.0735	-0.0194
dln(Expense)[-3]	-0.0331	0.0556	-0.5546	1.3521	-0.7458	0.0792
dln(Expense)[-4]	0.0529	-0.0242	0.0547	-0.5518	1.3508	-0.7481
dln(Expense)[-5]	-0.0217	0.0292	-0.0144	0.0587	-0.5545	1.3477

Number of observarions = 11267

Non-Staple Foods

	dln(Expense)	dln(Expense)[-1]	dln(Expense)[-2]	dln(Expense)[-3]	dln(Expense)[-4]	dln(Expense)[-5]
dln(Expense)	0.7081	-0.3702	0.0191	-0.0203	0.0290	-0.0041
dln(Expense)[-1]	-0.5299	0.6890	-0.3627	0.0296	-0.0123	0.0116
dln(Expense)[-2]	0.0272	-0.5244	0.6943	-0.3837	0.0232	0.0060
dln(Expense)[-3]	-0.0287	0.0424	-0.5475	0.7072	-0.3793	0.0180
dln(Expense)[-4]	0.0410	-0.0177	0.0332	-0.5368	0.7060	-0.3720
dln(Expense)[-5]	-0.0059	0.0167	0.0086	0.0256	-0.5304	0.6967

Number of observarions = 16538

Note: The first differences in household expenditures on foods, staple foods, and non-staple foods.
The upper triangle shows the variance and covariance, while the lower triangle shows the correlation.
The sample period covers Weeks 2-10.

Table 4: Descriptive Statistics

	N	Mean	St.d.	Min	Max
Sqrt (Frequency of Tremors)	88,496	0.1728	0.6511	0	4.7958
Infant Dummy	88,496	0.1246	0.3303	0	1
Fulltime Dummy	88,496	0.1445	0.3516	0	1
Number of Shoppings	88,496	2.9550	2.5751	0	23
Δshoppings	88,496	-0.0427	2.3417	-19	19
Shopping Interval of					
Foods	88,496	1.3607	1.0562	1	10
Staple Foods	88,496	1.5558	1.2695	1	10
Non Staple Foods	88,496	1.3654	1.0601	1	10
Tremors×Infant	88,496	0.0212	0.2363	0	4.7958
Tremors×Fulltime	88,496	0.0230	0.2441	0	4.7958
Tremors×Δshoppings	88,496	-0.0185	1.5601	-48	34.86
Tremors× Interval of					
Foods	88,496	0.2487	1.3269	0	47.96
Staple Foods	88,496	0.2895	1.5691	0	47.96
Non Staple Foods	88,496	0.2496	1.3310	0	47.96

Note: Sample statistics of the variables used in Tables 5, 6 and 7.

Sample Periods cover Weeks 4 - 11.

The number of tremors is the number of major tremors (greater than seismic intensity 3) observed in each prefecture each week

See the main text for definitions of other variables.

Table 5: The Effects of The Disaster on the First Differences in Expenditures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Δ Foods	Δ Foods	Δ Staple	Δ Staple	Δ Non Staple	Δ Non Staple	Δ Foods	Δ Foods	Δ Staple	Δ Staple	Δ Non Staple	Δ Non Staple
Week 11	-120.0**	-120.5**	23.94	23.99	-144.0***	-144.5***	-120.7**	-49.01	23.83	38.62**	-144.6***	-87.62**
	(57.50)	(57.51)	(21.32)	(21.33)	(47.14)	(47.15)	(57.51)	(44.15)	(21.33)	(19.69)	(47.15)	(37.45)
Tremor	68.55***	68.77***	52.73***	52.70***	15.82	16.07	83.88***	97.41***	62.68***	66.34***	21.20	31.07*
	(25.16)	(25.17)	(8.843)	(8.843)	(20.81)	(20.82)	(28.13)	(21.65)	(9.923)	(9.193)	(23.24)	(18.48)
Infant × Tremor							16.56	13.88	-26.25	-27.09*	42.81	40.98
							(50.16)	(42.13)	(17.19)	(16.22)	(41.08)	(35.02)
Fulltime × Tremor							-128.3**	-69.14	-50.11**	-36.49*	-78.14*	-32.64
							(57.46)	(45.57)	(21.12)	(19.68)	(47.46)	(38.75)
Δ Shopping Frequency × Tremor								-10.65		4.256		-14.91*
								(9.169)		(3.639)		(7.789)
Infant Dummy		-5.136		-0.242		-4.894	-8.061	-20.64	4.232	1.597	-12.29	-22.24
		(44.43)		(14.73)		(36.88)	(45.53)	(34.75)	(15.04)	(13.92)	(37.84)	(29.50)
Fulltime Dummy		-11.23		-2.474		-8.758	9.434	10.07	5.608	5.721	3.826	4.346
		(38.27)		(13.58)		(31.49)	(39.52)	(30.33)	(13.94)	(12.88)	(32.56)	(25.69)
Δ Shopping Frequency								1,077***		227.2***		849.8***
								(6.292)		(2.490)		(5.307)
Constant	40.97	66.55	-5.760	-2.950	46.73	69.50	64.37	45.34	-4.505	-8.537	68.88	53.88
	(34.57)	(61.77)	(12.60)	(21.23)	(28.76)	(51.85)	(61.82)	(47.49)	(21.25)	(19.85)	(51.88)	(40.88)
Model	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
HH Characteristics	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496
R-squared	0.008	0.009	0.003	0.003	0.008	0.008	0.009	0.419	0.003	0.145	0.008	0.384

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
Dependent variables are the first differences in expenditures.
Tremor is the square root of the number of major tremors.
Sample Periods: Weeks 4 - 11 in 2011.
Sample Places: All prefectures in Japan except the directly damaged prefectures and Okinawa.
HH Characteristics: Dummies for the size of households, dummies for six income categories, dummies for eight categories of wife's age, infant dummy, and fulltime-working wife dummy.
Staple food include rice, bread, noodles, cereal, flour, and pancake mix.
Week dummies are included in all the specifications. Week 4 = base week. March 11 is the first day of Week 11.

Table 6: The Effects of The Disaster on the Extensive Margins of Expenditures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Extensive Margin: Foods	Extensive Margin: Foods	Extensive Margin: Staple	Extensive Margin: Staple	Extensive Margin: Non Staple	Extensive Margin: Non Staple	Extensive Margin: Foods	Extensive Margin: Foods	Extensive Margin: Staple	Extensive Margin: Staple	Extensive Margin: Non Staple	Extensive Margin: Non Staple
Week 11	-0.0333***	-0.0339***	-0.0342***	-0.0352***	-0.0351***	-0.0357***	-0.0333***	-0.0339***	-0.0343***	-0.0352***	-0.0351***	-0.0357***
	(0.00541)	(0.00543)	(0.00624)	(0.00626)	(0.00547)	(0.00548)	(0.00541)	(0.00543)	(0.00624)	(0.00626)	(0.00547)	(0.00548)
Tremor	-0.0179***	-0.00318	-0.0117***	0.00330	-0.0175***	-0.00189	-0.0158***	-0.00207	-0.00978***	0.00430	-0.0155***	-0.000860
	(0.00247)	(0.00300)	(0.00281)	(0.00339)	(0.00248)	(0.00299)	(0.00263)	(0.00306)	(0.00299)	(0.00347)	(0.00264)	(0.00307)
Infant×Tremor							-0.0152**	-0.0108*	-0.0143**	-0.0103	-0.0139**	-0.00917
							(0.00629)	(0.00632)	(0.00658)	(0.00662)	(0.00629)	(0.00631)
Fulltime×Tremor							-0.00158	-0.00147	-0.00129	-0.000556	-0.00205	-0.00189
							(0.00610)	(0.00608)	(0.00684)	(0.00684)	(0.00612)	(0.00609)
Interval×Tremor		-0.0101***		-0.00882***		-0.0107***		-0.00984***		-0.00861***		-0.0105***
		(0.00121)		(0.00106)		(0.00117)		(0.00122)		(0.00108)		(0.00118)
Shopping Interval	0.0654***	0.0691***	0.0721***	0.0752***	0.0667***	0.0706***	0.0654***	0.0690***	0.0721***	0.0752***	0.0667***	0.0705***
	(0.00262)	(0.00273)	(0.00202)	(0.00209)	(0.00261)	(0.00272)	(0.00262)	(0.00273)	(0.00202)	(0.00209)	(0.00261)	(0.00272)
Constant	0.743***	0.738***	0.634***	0.629***	0.738***	0.733***	0.743***	0.738***	0.633***	0.629***	0.738***	0.733***
	(0.00439)	(0.00447)	(0.00435)	(0.00439)	(0.00440)	(0.00448)	(0.00439)	(0.00447)	(0.00435)	(0.00439)	(0.00440)	(0.00448)
Model	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
HH Characteristics	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Observations	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496	88,496
R-squared	0.027	0.027	0.030	0.030	0.027	0.028	0.027	0.028	0.030	0.030	0.027	0.028

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Dependent variables are the dummy variables for positive expenditures.

See the note for Table 6 for the detailed explanations.

Table 7: The Effects of The Disaster on the Intensive Margins of Expenditures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Intensive Margin: Foods	Intensive Margin: Foods	Intensive Margin: Staple	Intensive Margin: Staple	Intensive Margin: Non Staple	Intensive Margin: Non Staple	Intensive Margin: Foods	Intensive Margin: Foods	Intensive Margin: Staple	Intensive Margin: Staple	Intensive Margin: Non Staple	Intensive Margin: Non Staple
Week 11	-0.0134 (0.00869)	-0.0136 (0.00868)	0.129*** (0.0152)	0.130*** (0.0152)	-0.0329*** (0.00890)	-0.0331*** (0.00890)	-0.0134 (0.00868)	-0.00840 (0.00796)	0.130*** (0.0152)	0.135*** (0.0149)	-0.0330*** (0.00890)	-0.0284*** (0.00827)
Tremor	0.0399*** (0.00405)	0.0398*** (0.00405)	0.0962*** (0.00766)	0.0960*** (0.00766)	0.0266*** (0.00404)	0.0266*** (0.00404)	0.0399*** (0.00439)	0.0383*** (0.00975)	0.0993*** (0.00828)	0.0761*** (0.0142)	0.0258*** (0.00440)	0.0212** (0.00878)
Infant×Tremor							0.0208* (0.0113)	0.0190* (0.0109)	-0.00719 (0.0210)	-0.0101 (0.0209)	0.0251** (0.0112)	0.0235** (0.0108)
Fulltime×Tremor							-0.0176* (0.00963)	-0.0101 (0.00902)	-0.0218 (0.0195)	-0.0151 (0.0191)	-0.0145 (0.00922)	-0.00776 (0.00874)
Interval×Tremor								-0.000952 (0.00818)		0.0157 (0.00989)		0.00223 (0.00705)
ΔShopping Frequency ×Tremor								-0.000975 (0.00137)		0.00333 (0.00267)		-0.00260* (0.00135)
Infant Dummy		-0.00355 (0.00722)		-0.00848 (0.0118)		-0.00128 (0.00741)	-0.00661 (0.00729)	-0.00721 (0.00662)	-0.00747 (0.0118)	-0.00869 (0.0115)	-0.00498 (0.00750)	-0.00551 (0.00689)
Fulltime Dummy		-0.00474 (0.00522)		-0.00211 (0.00860)		-0.00495 (0.00538)	-0.00217 (0.00534)	-0.00119 (0.00485)	0.00105 (0.00866)	0.00286 (0.00844)	-0.00284 (0.00552)	-0.00182 (0.00508)
Shoppings Interval	0.0363*** (0.00294)	0.0380*** (0.00297)	0.0268*** (0.00331)	0.0274*** (0.00336)	0.0327*** (0.00295)	0.0344*** (0.00298)	0.0380*** (0.00297)	-0.0660*** (0.00292)	0.0274*** (0.00336)	-0.0370*** (0.00342)	0.0345*** (0.00298)	-0.0660*** (0.00298)
ΔShopping Frequency								0.0911*** (0.000726)		0.0744*** (0.00126)		0.0881*** (0.000754)
Constant	-0.0686*** (0.00581)	-0.0881*** (0.0111)	-0.0715*** (0.00854)	-0.0765*** (0.0177)	-0.0604*** (0.00594)	-0.0838*** (0.0114)	-0.0879*** (0.0111)	0.0119 (0.0102)	-0.0768*** (0.0177)	-0.0194 (0.0173)	-0.0835*** (0.0114)	0.0131 (0.0106)
Model	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
HH Characteristics	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	72,377	72,377	64,606	64,606	72,117	72,117	72,377	72,377	64,606	64,606	72,117	72,117
R-squared	0.007	0.007	0.014	0.014	0.005	0.006	0.007	0.192	0.014	0.066	0.006	0.169

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Dependent Variables are the ratio of the gap between actual and average expenditures divided by the average expenditures. Observations with zero expenditures are excluded.

See note for Table 6 for more detailed explanations.

Appedix Table 1: Weekly Frequency of Tremors whose Seismic Scale Is Greater Than 3.

		week																
pref_code	Prefecture Name	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	Hokkaido	0	0	0	0	0	0	4	0	0	1	0	0	0	0	0	0	0
2	Aomori	0	0	0	0	0	1	9	0	1	2	0	1	0	0	0	0	0
3	Iwate	0	0	0	0	0	1	27	3	4	4	3	0	0	1	1	0	0
4	Miyagi	0	0	0	0	0	2	30	8	5	5	3	1	3	0	0	0	0
5	Akita	0	0	0	0	0	1	8	1	0	2	1	1	0	0	0	0	0
6	Yamagata	0	0	0	0	0	1	13	0	1	1	2	0	1	0	0	0	0
7	Fukushima	0	1	0	0	0	1	37	8	4	4	19	4	4	4	2	3	2
8	Ibaraki	0	0	0	0	0	0	37	9	2	5	11	3	3	1	1	0	4
9	Tochigi	0	0	0	0	0	0	16	6	0	2	5	2	1	0	0	0	0
10	Gumma	0	0	0	0	0	0	5	1	0	2	3	1	1	0	0	0	0
11	Saitama	0	0	0	0	0	0	10	2	0	2	4	2	0	0	0	0	0
12	Chiba	0	1	0	0	0	0	15	3	0	2	3	2	1	0	0	0	2
13	Tokyo	0	0	0	0	0	0	4	0	0	0	2	1	0	0	0	0	0
14	Kanagawa	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0
15	Niigata	0	0	0	0	0	0	10	0	0	1	2	1	0	0	0	0	0
16	Toyama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Ishikawa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
18	Fukui	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Yamanashi	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
20	Nagano	0	0	0	0	0	0	23	0	1	0	2	0	0	0	0	0	0
21	Gifu	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0
22	Shizuoka	1	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
23	Aichi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
24	Mie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Saga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Kyoto	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Osaka	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Hyogo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Nara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Wakayama	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
31	Tottori	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Shimane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Okayama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Hiroshima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Yamaguchi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	Tokushima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Kagawa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	Ehime	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	Kochi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	Fukuoka	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	Saga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Nagasaki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	Kumamoto	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	Oita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	Miyazaki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	Kagoshimia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: No major earthquakes occurred during in Week 2, 3, 4, and 7.
Source: Japan Meteorological Agency

Appendix Table 2: Movements of ln(Expenditures) on Staple Foods

	East			West			All		
Week	N	mean	sd	N	mean	sd	N	mean	sd
2	2791	6.41	1.00	3670	6.34	0.99	8174	6.37	1.00
3	2787	6.42	1.02	3748	6.38	0.97	8317	6.39	1.00
4	2771	6.43	1.04	3789	6.39	0.98	8330	6.40	1.01
5	2882	6.49	1.05	3887	6.39	1.02	8546	6.43	1.04
6	2780	6.49	1.00	3710	6.39	0.99	8229	6.41	1.00
7	2796	6.47	1.02	3710	6.39	1.00	8255	6.42	1.01
8	2775	6.49	1.03	3743	6.41	0.99	8251	6.43	1.02
9	2903	6.54	1.06	3931	6.42	1.02	8623	6.46	1.04
10	2786	6.51	1.03	3697	6.41	0.98	8208	6.43	1.00
11	2727	7.01	1.07	3718	6.49	1.01	8167	6.71	1.07
12	2555	6.66	1.05	3670	6.42	1.00	7860	6.50	1.03
13	2695	6.51	1.06	3745	6.41	1.03	8134	6.45	1.05
14	2512	6.43	0.99	3505	6.35	1.01	7642	6.37	1.00
15	2724	6.46	1.00	3710	6.35	0.99	8130	6.39	1.00
16	2708	6.46	1.03	3687	6.41	0.99	8105	6.42	1.01
17	2782	6.49	1.02	3816	6.42	1.00	8310	6.43	1.02
18	2627	6.50	1.03	3509	6.45	1.02	7764	6.46	1.03
19	2667	6.43	1.02	3694	6.37	0.98	8029	6.39	1.00
20	2716	6.49	0.99	3715	6.39	0.99	8155	6.42	1.00
21	2837	6.54	1.02	3846	6.46	0.99	8396	6.47	1.02
	54821	6.51	1.03	74500	6.40	1.00	163625	6.44	1.02

Appendix Table 3: Weekly Shopping Frequencies

	East					West					All				
week	N	mean	sd	min	max	N	mean	sd	min	max	N	mean	sd	min	max
2	3853	2.94	2.54	0	15	5063	2.86	2.44	0	20	11312	2.83	2.44	0	20
3	3853	2.99	2.62	0	19	5063	3.00	2.55	0	22	11312	2.94	2.53	0	22
4	3853	3.04	2.68	0	18	5063	3.04	2.61	0	19	11312	2.98	2.58	0	19
5	3853	3.25	2.71	0	19	5063	3.13	2.59	0	22	11312	3.13	2.60	0	22
6	3853	3.07	2.75	0	20	5063	2.97	2.59	0	23	11312	2.94	2.60	0	23
7	3853	2.93	2.60	0	18	5063	2.93	2.54	0	21	11312	2.90	2.54	0	21
8	3853	3.00	2.63	0	18	5063	3.01	2.58	0	19	11312	2.94	2.56	0	20
9	3853	3.30	2.69	0	18	5063	3.20	2.59	0	19	11312	3.18	2.59	0	19
10	3853	3.00	2.68	0	19	5063	2.93	2.57	0	23	11312	2.91	2.58	0	23
11	3853	3.13	2.92	0	21	5063	2.94	2.56	0	18	11312	2.97	2.67	0	21
12	3853	2.85	2.81	0	22	5063	2.81	2.51	0	17	11312	2.77	2.58	0	22
13	3853	3.07	2.83	0	22	5063	2.98	2.57	0	21	11312	2.95	2.63	0	22
14	3853	2.82	2.80	0	24	5063	2.80	2.60	0	22	11312	2.75	2.62	0	24
15	3853	3.01	2.74	0	21	5063	2.93	2.54	0	19	11312	2.91	2.58	0	21
16	3853	3.04	2.78	0	21	5063	3.01	2.63	0	17	11312	2.97	2.63	0	21
17	3853	3.06	2.72	0	18	5063	3.06	2.61	0	19	11312	2.99	2.62	0	19
18	3853	2.84	2.71	0	17	5063	2.82	2.61	0	21	11312	2.78	2.59	0	21
19	3853	2.92	2.66	0	21	5063	2.92	2.53	0	19	11312	2.87	2.55	0	21
20	3853	3.03	2.75	0	19	5063	2.99	2.59	0	19	11312	2.95	2.61	0	19
21	3853	3.15	2.75	0	20	5063	3.14	2.60	0	18	11312	3.06	2.62	0	20
Total	77060	3.02	2.72	0	24	101260	2.97	2.57	0	23	226240	2.94	2.59	0	24

Appendix Table 4: Shopping Inverval (in Weeks)

week	East									West								
	Foods			Staple			Non Staple			Foods			Staple			Non Staple		
	N	mean	sd	N	mean	sd	N	mean	sd	N	mean	sd	N	mean	sd	N	mean	sd
3	3136	1.10	0.30	2787	1.18	0.38	3127	1.11	0.31	4172	1.11	0.32	3748	1.18	0.39	4159	1.12	0.32
4	3143	1.15	0.44	2771	1.25	0.57	3130	1.15	0.45	4194	1.16	0.47	3789	1.25	0.58	4179	1.16	0.47
5	3283	1.25	0.69	2882	1.36	0.80	3262	1.25	0.70	4294	1.20	0.61	3887	1.30	0.72	4279	1.20	0.61
6	3119	1.14	0.51	2780	1.28	0.74	3104	1.14	0.52	4092	1.14	0.50	3710	1.26	0.73	4077	1.14	0.51
7	3125	1.16	0.54	2796	1.29	0.77	3113	1.17	0.56	4121	1.16	0.55	3710	1.26	0.71	4108	1.17	0.55
8	3148	1.19	0.61	2775	1.31	0.81	3142	1.19	0.62	4176	1.20	0.64	3743	1.30	0.80	4166	1.20	0.65
9	3279	1.28	0.89	2903	1.47	1.20	3265	1.28	0.90	4389	1.28	0.94	3931	1.43	1.14	4377	1.29	0.94
10	3099	1.17	0.72	2786	1.30	0.91	3088	1.17	0.72	4112	1.14	0.68	3697	1.28	0.90	4096	1.15	0.68
11	2960	1.15	0.56	2727	1.30	0.87	2949	1.15	0.58	4101	1.15	0.56	3718	1.27	0.78	4077	1.16	0.57
12	2907	1.20	0.59	2555	1.29	0.77	2889	1.20	0.60	4055	1.17	0.54	3670	1.31	0.87	4039	1.17	0.55
13	3067	1.40	1.12	2695	1.56	1.33	3054	1.40	1.12	4192	1.28	0.87	3745	1.43	1.16	4172	1.28	0.87
14	2893	1.30	1.20	2512	1.41	1.24	2875	1.31	1.20	3922	1.25	1.13	3505	1.37	1.22	3908	1.25	1.13
15	3092	1.24	0.72	2724	1.42	1.06	3079	1.25	0.73	4125	1.20	0.64	3710	1.33	0.88	4107	1.21	0.66
16	3098	1.20	0.71	2708	1.37	0.99	3086	1.21	0.73	4080	1.18	0.72	3687	1.31	0.93	4067	1.19	0.73
17	3124	1.23	0.77	2782	1.42	1.14	3113	1.25	0.81	4248	1.24	0.82	3816	1.37	1.10	4238	1.24	0.83
18	2977	1.32	1.40	2627	1.46	1.54	2962	1.32	1.34	3941	1.29	1.35	3509	1.44	1.57	3917	1.29	1.35
19	3052	1.24	0.81	2667	1.40	1.16	3038	1.25	0.92	4105	1.24	0.95	3694	1.40	1.18	4084	1.25	0.94
20	3096	1.21	0.74	2716	1.38	1.10	3087	1.22	0.74	4163	1.18	0.68	3715	1.31	0.87	4150	1.19	0.71
21	3174	1.22	0.78	2837	1.40	1.18	3168	1.22	0.79	4223	1.19	0.70	3846	1.34	0.97	4208	1.19	0.70
Total	61930	1.21	0.77	54821	1.34	0.99	61671	1.21	0.78	82804	1.19	0.74	74500	1.31	0.94	82494	1.19	0.74

Note: The shopping interval from the last purchse. In each week, only hoseholds with positive purchases are included when calculatin this table.

Appendix Table 5: The Ratio of HHs with Positive Expenditures

	East			West			All		
week	Foods	Staple	Non Staple	Foods	Staple	Non Staple	Foods	Staple	Non Staple
2	0.82	0.72	0.81	0.81	0.72	0.81	0.82	0.72	0.81
3	0.81	0.72	0.81	0.82	0.74	0.82	0.82	0.74	0.82
4	0.82	0.72	0.81	0.83	0.75	0.83	0.83	0.74	0.82
5	0.85	0.75	0.85	0.85	0.77	0.85	0.85	0.76	0.84
6	0.81	0.72	0.81	0.81	0.73	0.81	0.81	0.73	0.81
7	0.81	0.73	0.81	0.81	0.73	0.81	0.81	0.73	0.81
8	0.82	0.72	0.82	0.82	0.74	0.82	0.82	0.73	0.82
9	0.85	0.75	0.85	0.87	0.78	0.86	0.86	0.76	0.85
10	0.80	0.72	0.80	0.81	0.73	0.81	0.81	0.73	0.81
11	0.77	0.71	0.77	0.81	0.73	0.81	0.79	0.72	0.79
12	0.75	0.66	0.75	0.80	0.72	0.80	0.78	0.69	0.78
13	0.80	0.70	0.79	0.83	0.74	0.82	0.81	0.72	0.81
14	0.75	0.65	0.75	0.77	0.69	0.77	0.77	0.68	0.76
15	0.80	0.71	0.80	0.81	0.73	0.81	0.81	0.72	0.81
16	0.80	0.70	0.80	0.81	0.73	0.80	0.81	0.72	0.80
17	0.81	0.72	0.81	0.84	0.75	0.84	0.82	0.73	0.82
18	0.77	0.68	0.77	0.78	0.69	0.77	0.78	0.69	0.77
19	0.79	0.69	0.79	0.81	0.73	0.81	0.80	0.71	0.80
20	0.80	0.70	0.80	0.82	0.73	0.82	0.81	0.72	0.81
21	0.82	0.74	0.82	0.83	0.76	0.83	0.83	0.74	0.82
Total	0.80	0.71	0.80	0.82	0.74	0.81	0.81	0.72	0.81

Appendix Table 6: Intensive Margin

	East						West						All					
	Foods		Staple		Non Staple		Foods		Staple		Non Staple		Foods		Staple		Non Staple	
Week	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
2	-0.07	0.44	-0.06	0.68	-0.07	0.45	-0.08	0.44	-0.05	0.65	-0.08	0.45	-0.08	0.44	-0.06	0.67	-0.08	0.45
3	-0.05	0.45	-0.05	0.69	-0.04	0.46	-0.03	0.44	-0.03	0.64	-0.03	0.46	-0.04	0.45	-0.04	0.67	-0.03	0.46
4	-0.03	0.46	-0.06	0.68	-0.02	0.48	-0.02	0.45	-0.02	0.66	-0.02	0.47	-0.03	0.46	-0.04	0.68	-0.02	0.47
5	0.02	0.48	0.01	0.73	0.02	0.49	0.01	0.47	-0.01	0.69	0.02	0.49	0.01	0.48	0.00	0.71	0.02	0.49
6	-0.01	0.47	0.00	0.74	-0.01	0.48	-0.02	0.45	-0.01	0.69	-0.02	0.47	-0.02	0.46	-0.01	0.71	-0.02	0.47
7	-0.03	0.46	-0.01	0.71	-0.03	0.47	-0.03	0.46	-0.02	0.67	-0.02	0.47	-0.02	0.46	-0.01	0.70	-0.02	0.48
8	-0.02	0.47	0.01	0.73	-0.03	0.48	-0.02	0.46	0.00	0.69	-0.03	0.47	-0.03	0.46	0.00	0.71	-0.03	0.47
9	0.04	0.47	0.03	0.73	0.04	0.48	0.02	0.48	0.01	0.68	0.02	0.50	0.03	0.48	0.01	0.71	0.03	0.49
10	-0.05	0.48	0.03	0.82	-0.05	0.51	-0.06	0.48	0.02	0.78	-0.06	0.50	-0.06	0.48	0.01	0.80	-0.06	0.50
11	0.10	0.56	0.41	1.02	0.03	0.55	-0.05	0.49	0.08	0.85	-0.06	0.50	0.01	0.52	0.21	0.94	-0.02	0.52
12	-0.09	0.49	0.12	0.88	-0.11	0.50	-0.07	0.49	0.03	0.79	-0.08	0.51	-0.08	0.49	0.05	0.84	-0.09	0.51
13	-0.06	0.51	0.02	0.84	-0.05	0.52	-0.05	0.51	-0.01	0.79	-0.04	0.53	-0.05	0.51	0.00	0.82	-0.05	0.52
14	-0.11	0.46	-0.07	0.76	-0.09	0.49	-0.11	0.46	-0.04	0.76	-0.10	0.49	-0.11	0.47	-0.06	0.76	-0.09	0.49
15	-0.05	0.48	-0.02	0.79	-0.04	0.50	-0.09	0.46	-0.05	0.74	-0.08	0.48	-0.07	0.47	-0.04	0.77	-0.06	0.49
16	-0.07	0.48	-0.03	0.80	-0.05	0.49	-0.04	0.47	0.01	0.79	-0.04	0.49	-0.05	0.47	-0.01	0.79	-0.04	0.49
17	-0.04	0.49	0.01	0.83	-0.03	0.51	-0.04	0.49	0.01	0.77	-0.03	0.52	-0.04	0.49	0.00	0.79	-0.03	0.52
18	-0.04	0.53	0.00	0.82	-0.03	0.55	-0.05	0.51	0.02	0.82	-0.04	0.54	-0.04	0.52	0.01	0.82	-0.03	0.54
19	-0.08	0.48	-0.04	0.79	-0.06	0.51	-0.08	0.49	-0.04	0.76	-0.07	0.52	-0.08	0.48	-0.04	0.77	-0.06	0.51
20	-0.04	0.47	0.01	0.81	-0.03	0.49	-0.07	0.47	-0.01	0.76	-0.07	0.50	-0.06	0.47	0.00	0.79	-0.05	0.50
21	-0.02	0.48	0.05	0.84	-0.01	0.51	0.00	0.49	0.06	0.80	0.00	0.51	-0.02	0.49	0.04	0.82	-0.01	0.51
Total	-0.03	0.48	0.02	0.79	-0.03	0.50	-0.04	0.47	0.00	0.74	-0.04	0.49	-0.04	0.48	0.00	0.77	-0.04	0.50

Figure 1-(a): The Frequency of Major Tremours in Weeks 8-9

Figure 1-(b): The Frequency of Major Tremours in Weeks 11-12

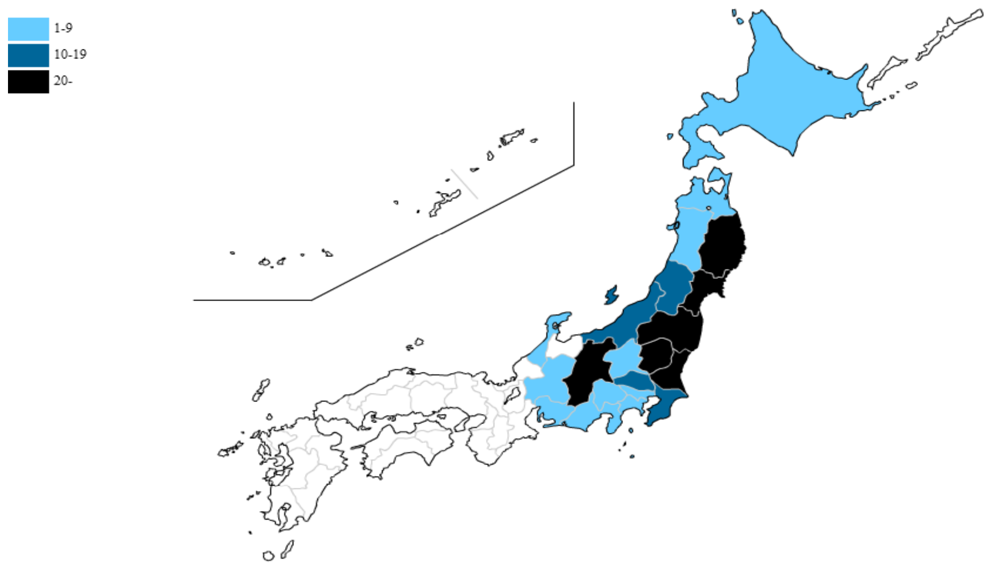


Figure 1-(C): The Frequency of Major Tremours in Weeks 13-14

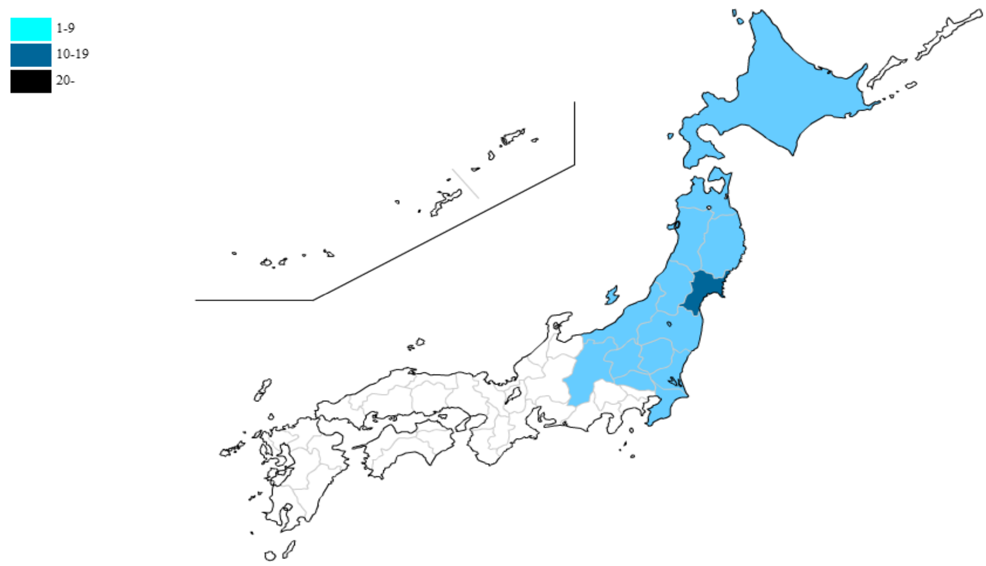
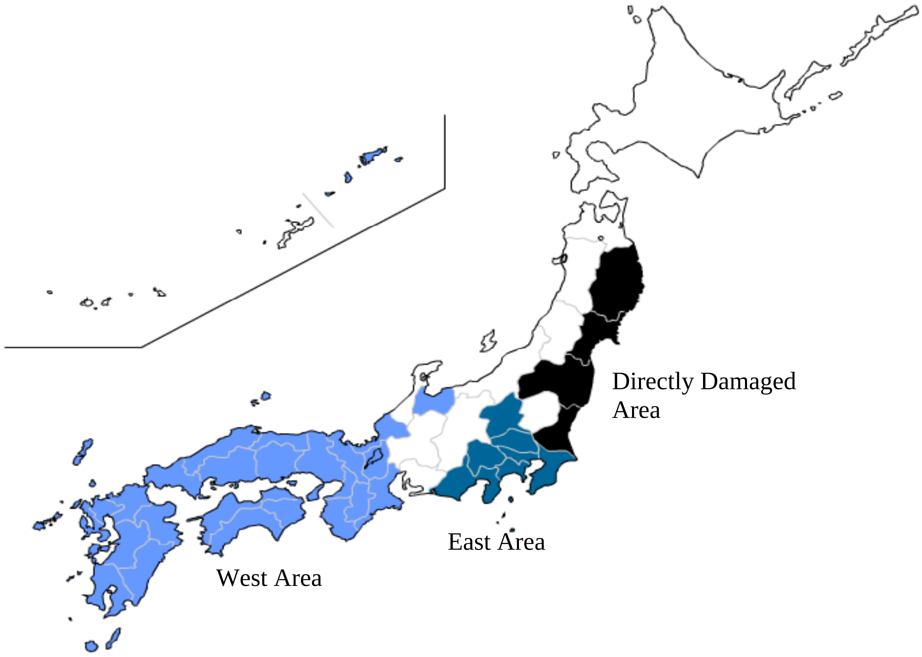
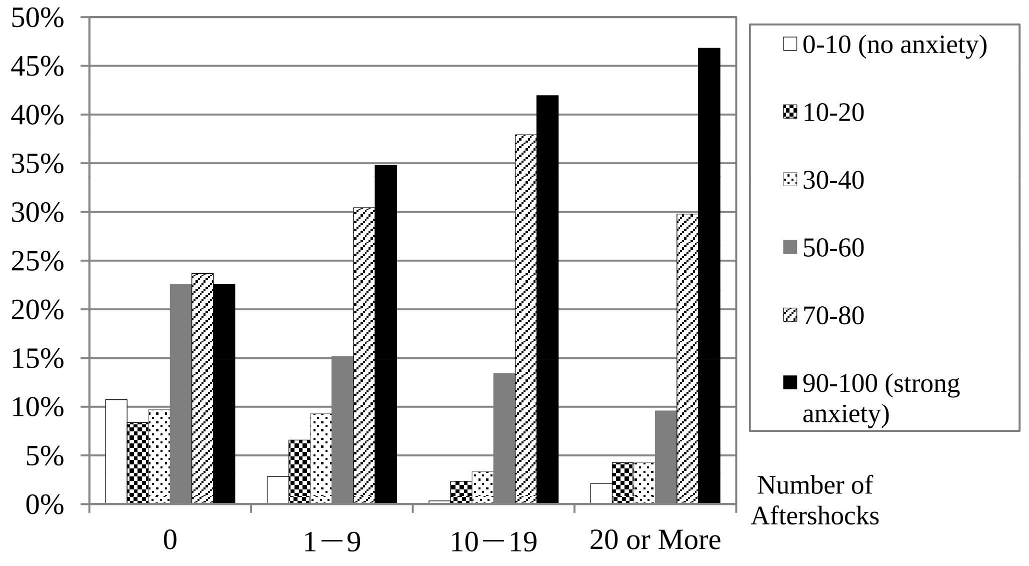


Figure 2: The Area Classification



Note: Classifications of Prefectures
Directly Damaged Area: Iwate, Miyagi, Fukushima, Ibaraki
East Area: Tokyo, Saitama, Gumma, Chiba,Kanagawa, Yamanashi, Shizuoka
West Area: Toyama, Fukui, Mie, Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama, Tottori,
Shimane, Okayama, Hiroshima, Yamaguchi, Tokushima, Kagawa, Ehime, Kochi,

Figure 3: Household's Anxiety Level
by the Number of Aftershocks Experienced



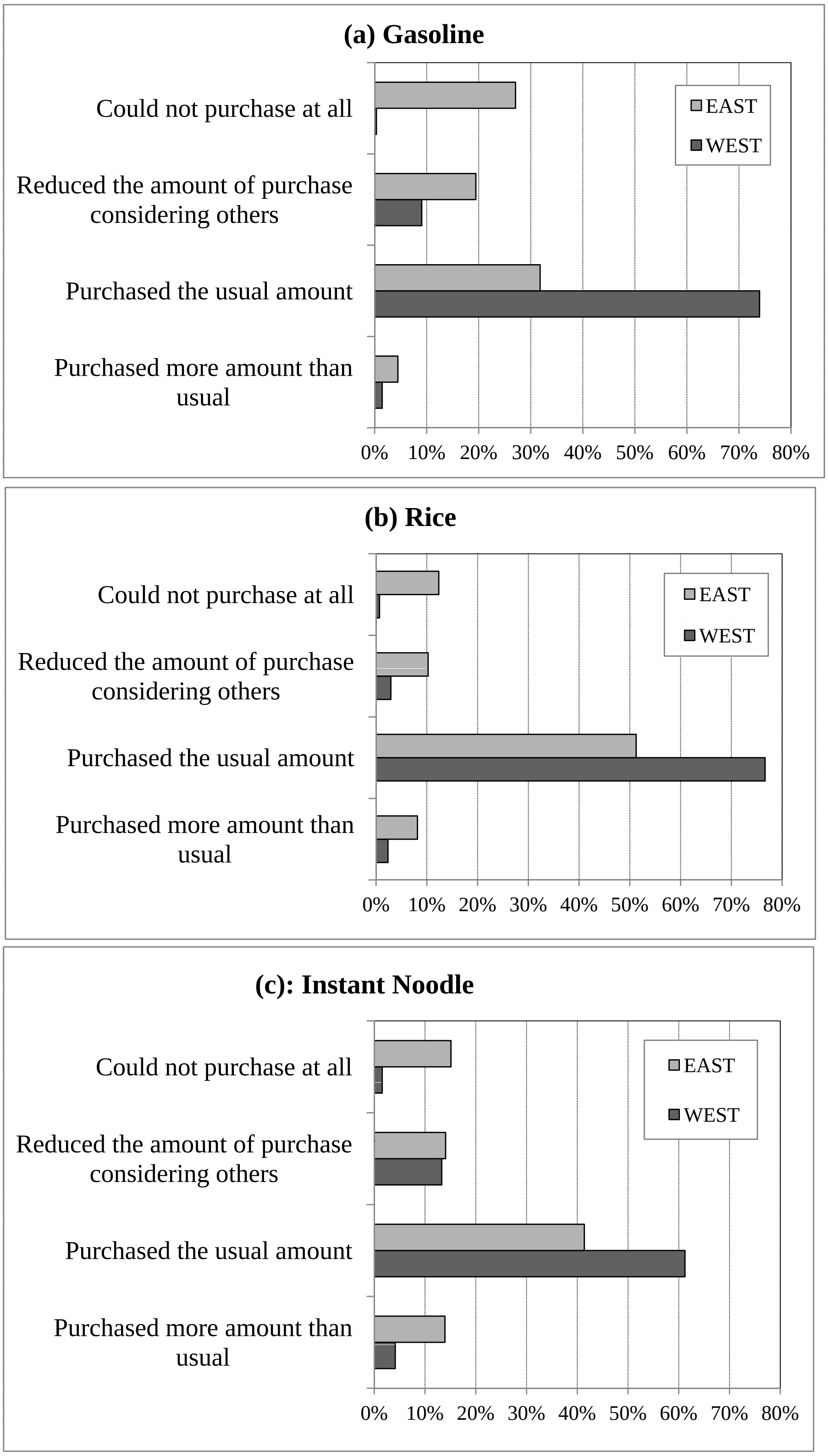
Notes:

1) The sample consists of 2,134 households in the Keio Household Panel Survey conducted in June 2011.

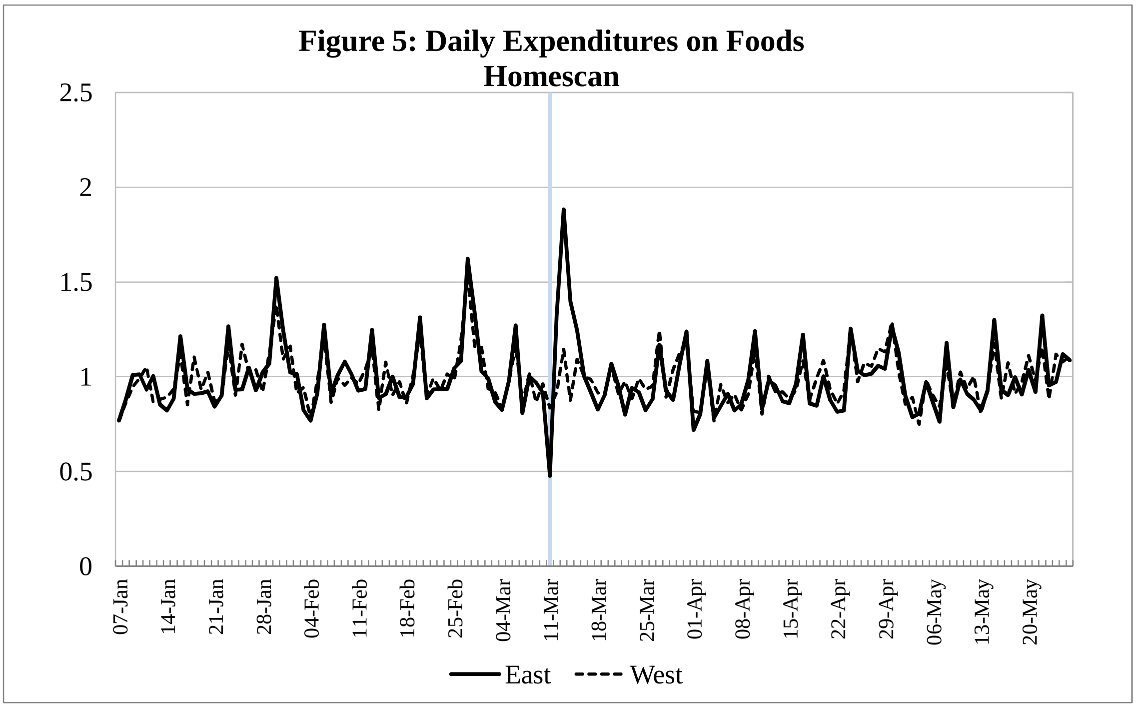
2) Households were asked to rate their feeling of "fear and anxiety about possible aftershocks" right affter the earthquake using Anxiety Level between 0 (=felt no fear or anxiety) and 100 (=felt strong fear and anxiety).

3) Households were classified by the number of major aftershocks (of seismic intensity greater than 3) in Week 11 (March 11-17) in their prefecture of residence.

Figure 4: Distribution of Households by the Outcome of Purchase After the Earthquake



Notes:
The sample consists of 1,579 married households from the Keio Household Panel Survey.
Households were asked to select from multiple choices that fit their experience in purchasing a specified good right after the earthquake.
As some choises were omitted from the above figures, the sum of the four answers may be less than 100%.
For the definitions of East and West, see Figure 2 and Section 2.



Note: The aggregate household expenditure on foods based on homescan data provided by Intagae.
The avearage expenditure before March 11 is normalized to unity.
See the notes in Figure 2 for the definition of East and West.

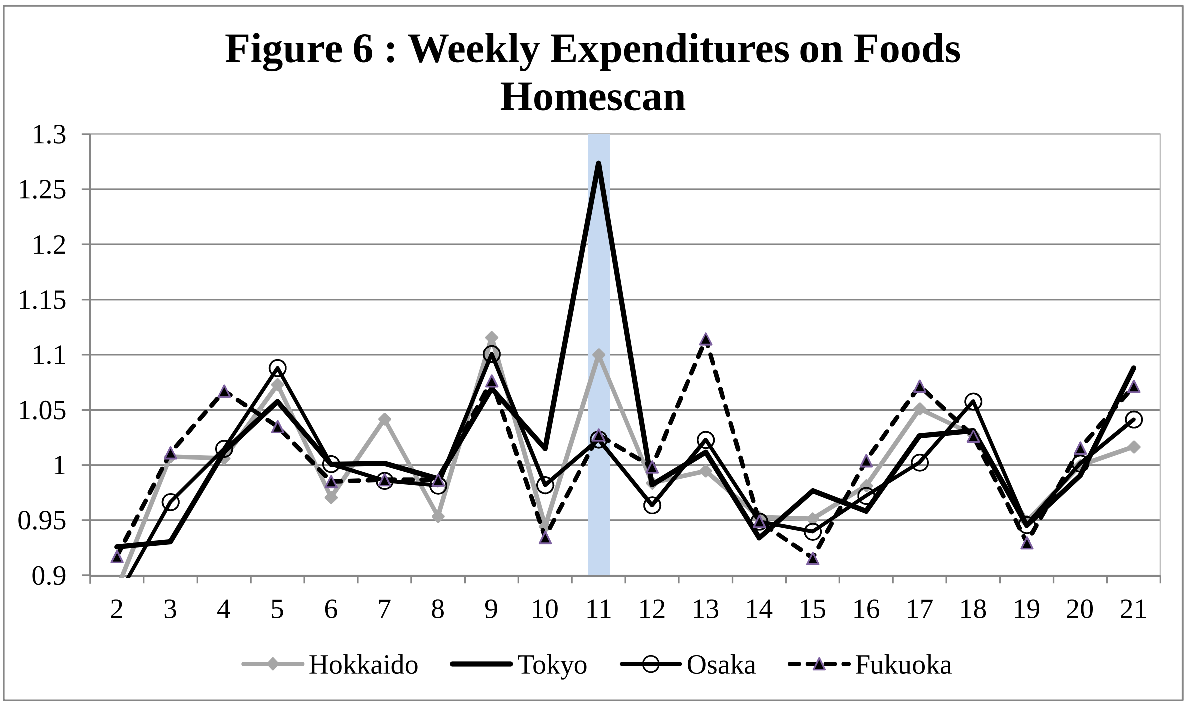


Figure 6 : Weekly Expenditures on Foods
Homescan
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Hokkaido
Tokyo
Osaka
Fukuoka

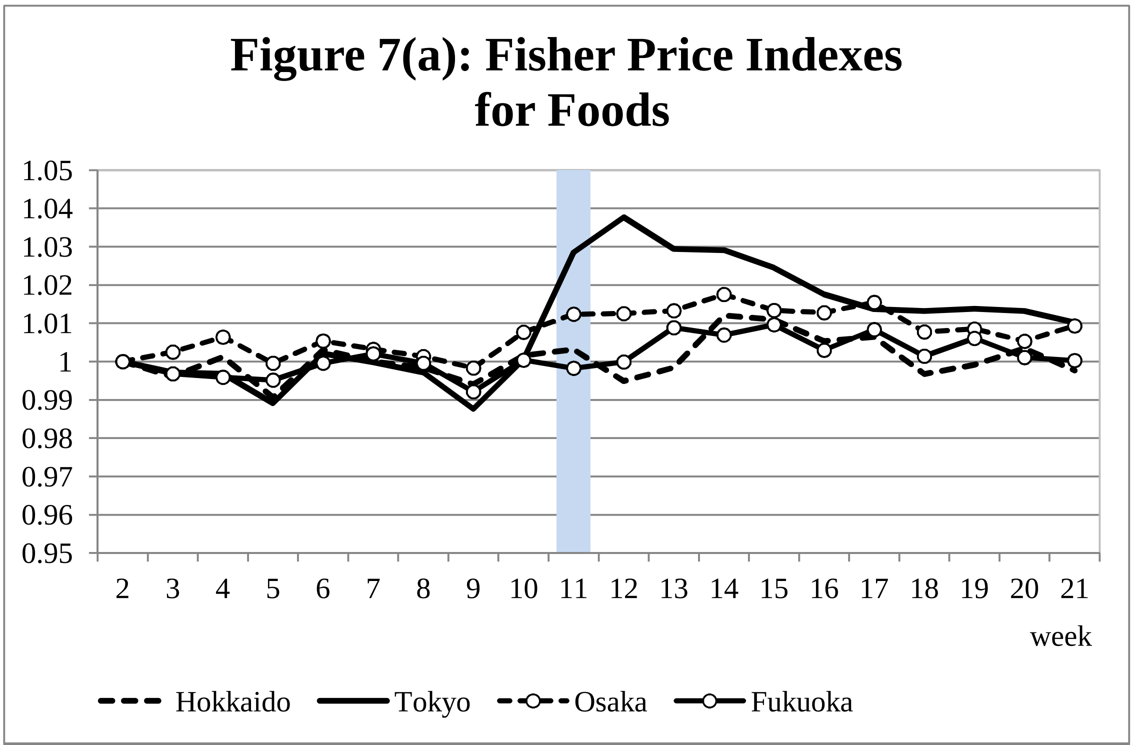


Figure 7(a): Fisher Price Indexes for Foods
1.05
1.04
1.03
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
week
Hokkaido
Tokyo
Osaka
Fukuoka

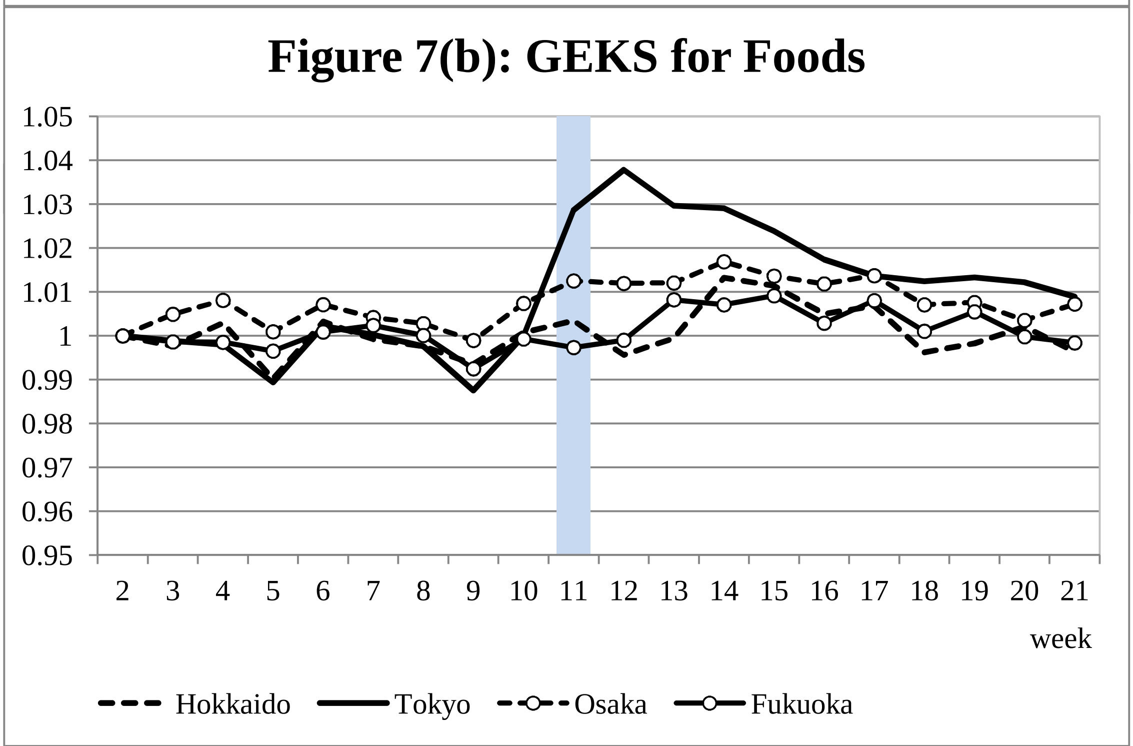
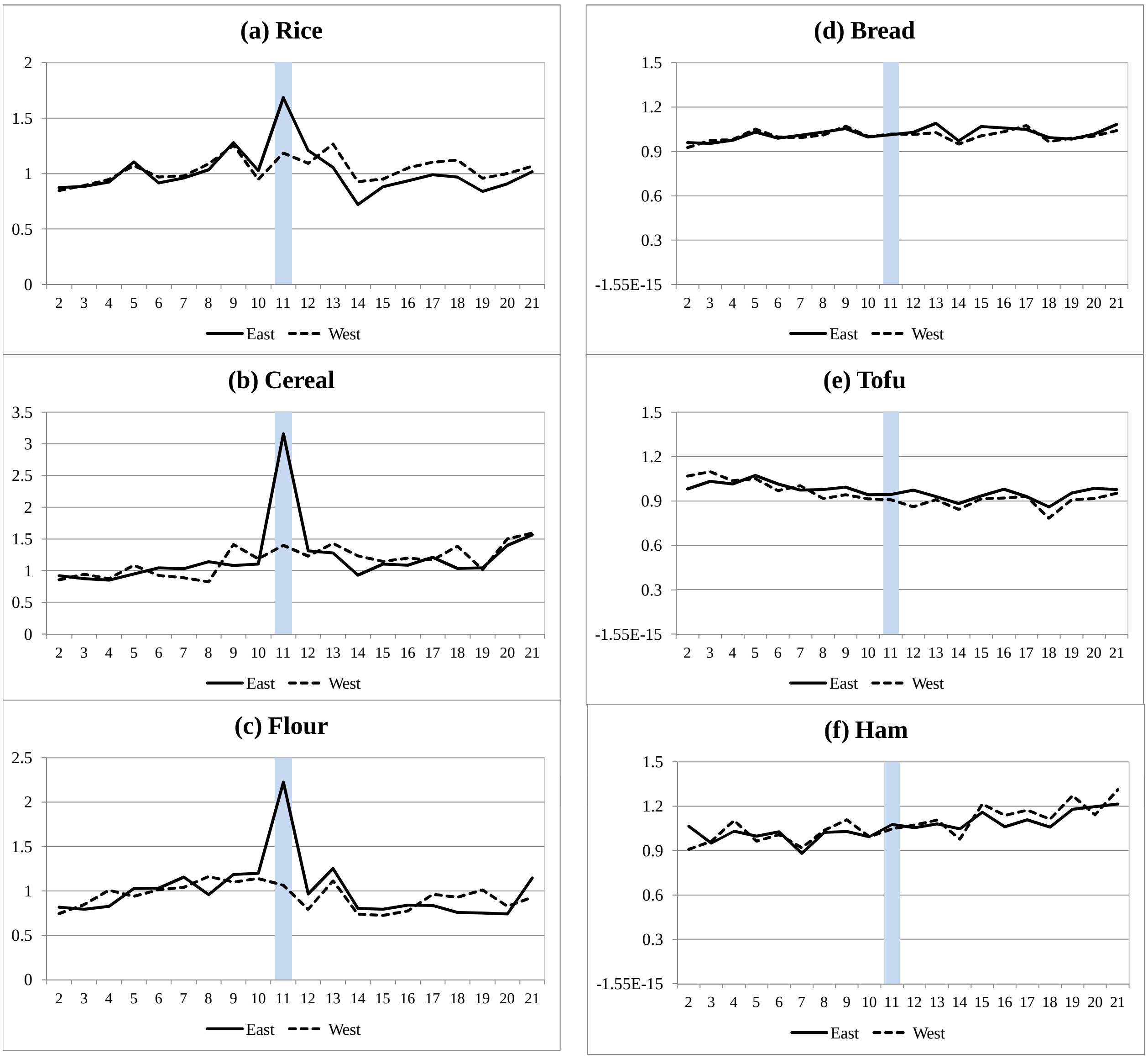


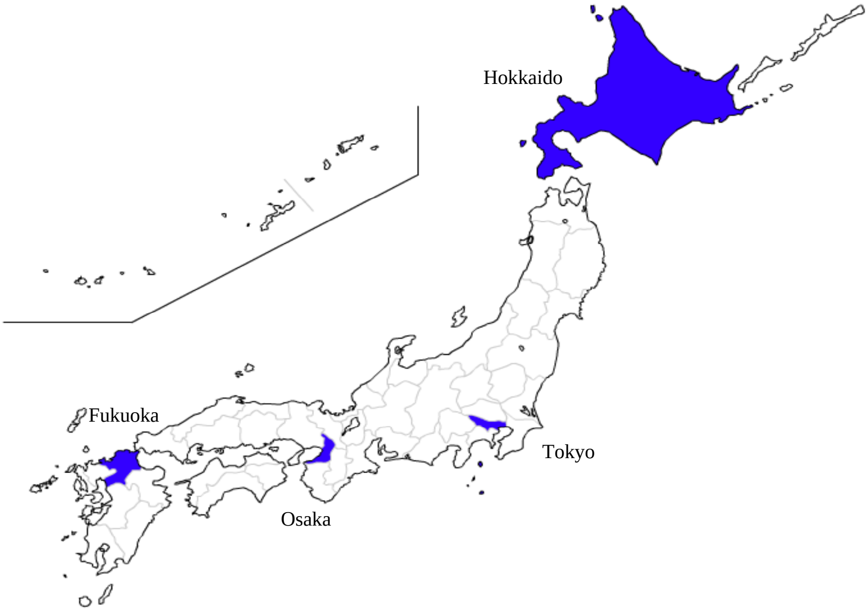
Figure 7(b): GEKS for Foods
1.05
1.04
1.03
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
week
Hokkaido
Tokyo
Osaka
Fukuoka

Figure 8: Expenditures on Six Food Categories

Storable Goods **Perishable Goods**



Appendix Figure 1: Four major Prefectures



Appendix Figure2: Price Indexes in Four Major Prefectures