

How Did the Semi-Lockdown Change Consumers' Food Shopping Patterns?: Focus on Offline and Online Channels

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1. Introduction

COVID-19 Pandemic and Food Consumption

- COVID-19 was first confirmed in late 2019 and became a pandemic in 2020.
 - Significant impact on our lives
- Many countries have made efforts to stop the spread of infection by restricting activities through measures such as lockdowns.
- Japan also implemented the semi-lockdown, we called the declaration of state of emergency, from April 7 to May 25, 2020.
- Because it was a "semi"-lockdown, people did not impose mandatory restrictions on activities, it requested that schools and businesses close and that the public refrain from going out.

Changes in Food Consumption during the Pandemic

- The measures force people to change their food consumption behavior, such as eating habits
 - **Changes eating habits**(Grashuis et al., 2020; Molina-Montes et al., 2021; Rodrigues et al., 2022)
 - **Hoarding or panic buying before lockdown**(Baker et al., 2020; Bentall et al., 2021; Kassas and Nayga, 2021; Wang and Hao, 2020)
- O'Connell et al. (2021) broke down the factors associated with the change in purchases of all food items in the UK immediately prior to the lockdown.
 - They found that the increase in purchase frequency for many items contributed greatly to the increase in the total purchase.

Online Shopping

- Baker et al. (2020) showed behavioral restrictions have led to online food shopping purchases such as food shopping delivery services.
- The increase in online food shopping purchases was also reported in the analysis results of various countries.
 - After the lockdowns were declared, offline purchases decreased while online purchases increased
 - France(Bounie et al., 2020), US(Chenarides et al., 2021; Ellison et al., 2021), Taiwan(Chang and Meyerhoefer, 2021)

The Situation in Japan

- In Japan, behavioral restrictions with penalties were not applied as in other countries.
- As the government requested to refrain from going out, it resulted in an increase in food shopping.
 - Many people had more opportunities to eat at home because they spent more time at home(cf. Konishi et al., 2021; Watanabe and Omori, 2020).
- However, people were **requested** to stay at home, but there were **no legal restrictions** and **people were able to go out**.
 - Some might go shopping at supermarkets, and others might use online shopping to avoid infection.
- Therefore, COVID-19 may have affected the food shopping behavior in Japan through various factors, each of which may act to increase or decrease food purchases, unlike in other countries.

Hypotheses

- I hypothesized the following 4 factors regarding purchase frequency and patterns during the pandemic in Japan.
 1. The increased opportunities to eat at home increased the food expenditures per purchase, regardless of whether it was an online or offline purchase.
 2. The increased opportunities to eat at home were dealt with by an increase in the frequency of food purchases.
 3. Fear of COVID-19 infection led to an increase in food purchases through online channels that did not require going out.
 4. People continued to use offline channels as before, since it was possible to go out.
- Although there were factors that promoted the use of online channels, it is unclear whether they were enough to reduce the use of offline channels.

Objectives of this study

- This study breaks down the factors that influence these shopping behaviors into...
 - parts that change the **spend per food purchase** and
 - parts that change **purchase frequency**, allowing the study to examine how these parts influence food purchases.
- Examining the factors that influenced changes in food expenditures by online and offline purchase channels for two periods immediately before and after the declaration of the state of emergency.
- Using the O'Connell et al. (2021) framework, break down changes in spending on a given item by channel.

2. Method

- Explaining calculation method along with O'Connell et al. (2021) to measure change the same period in 2019 and 2020
 - 2 periods: **3/9-4/5** and **4/6-5/3** in each year
- Very rough expression of this framework: $Expenditure = Purchase\ Freq. \times Expenditure\ per\ Purchase$
- The concept of this analysis is the extent to which the declaration of the state of emergency contributes to changes in spending through frequency and spending per purchase.
- Decompose changes in spend into **purchase frequency** and **spend per purchase** in **Online and Offline channels**

Expenditure per day per household for item category j

- Average expenditure per day per household for item category j in year y ($y = \{2019, 2020\}$)
- EX_{jy} is defined (1)
 - regardless of the type of online/offline

$$EX_{jy} = \frac{\sum_i \sum_{t \in P_y} ex_{ijt}}{N} \quad (1)$$

where $N = \# \text{ of Household} \times 28$

- The numerator of Eq. (1) is the sum of the expenditure(ex_{ijt}) by household i on item category j on day t
 - P_y is the 28-days in each period within year y
- N represents all possible opportunities to buy foods
 - It means that all shopping occasions (unit: days) by consumers included dataset.
- ΔEX_j is defined changes from 2019 to 2020 as below equation:
$$\Delta EX_j = EX_{j,2020} - EX_{j,2019}$$

Average Expenditure per day of purchase by type for item category j in year y

- $EX_{jy}^{c,type}$
 - The sum of expenditure ex_{ijt}^{type} in each channel type is divided by $N_{jy}^{+,type}$
 - It means that **Average Expenditure per day of purchase by type.**
- $N_{jy}^{+,type}$
 - The number of days where household i spent on item category j through a given channel $type$
 - It means the number of days consumers bought something within 28 days.

$$EX_{jy}^{c,type} = \frac{1}{N_{jy}^{+,type}} \sum_i \sum_{t \in P_y} ex_{ijt}^{type} \quad (2)$$

$$where N_{jy}^{+,type} = \sum_i \sum_{t \in P_y} 1\{ex_{ijt}^{type} > 0\}$$

Purchase Frequency

- D_{jy}^{type}
 - Purchase frequency is defined by Eq.(3)
 - $\Delta D_j^{type} = D_{j,2020}^{type} - D_{j,2019}^{type}$
 - It means that the ratio of days when consumers bought something from each channel.

$$D_{jy}^{type} = \frac{N_{jy}^{+,type}}{N} \quad (3)$$

Average Expenditure per day \times Purchase Frequency of Each Channel Type

$$EX_{jy} = \sum_{type} EX_{jy}^{c,type} \times D_{jy}^{type} \quad (4)$$

$$\begin{aligned}\Delta EX_j = & \underbrace{EX_{j2019}^{c,Off} \times \Delta D_j^{Off}}_{\text{Extensive margin for Offline}} + \underbrace{D_{j2019}^{Off} \times \Delta EX_j^{c,Off}}_{\text{Intensive margin for Offline}} + \\ & \underbrace{\Delta D_j^{Off} \times \Delta EX_j^{c,Off}}_{\text{Covariance for Offline}} + \\ & \underbrace{EX_{j2019}^{c,On} \times \Delta D_j^{On}}_{\text{Extensive margin for Online}} + \underbrace{D_{j2019}^{On} \times \Delta EX_j^{c,On}}_{\text{Intensive margin for Online}} + \\ & \underbrace{\Delta D_j^{On} \times \Delta EX_j^{c,On}}_{\text{Covariance for Online}}\end{aligned}\tag{5}$$

- Eq. (5) represents breaking down the changes in expenditure into purchase frequency, expenditure per purchase, and channel type.

- As shown in Eq. (5), either EX or D is a fixed value of 2019, and the other is changed to measure the effect.
- **Extensive margin:** To measure the impact of change in purchase frequency at channel type (ΔD_j^{type}) (expenditure fixed at the level in 2019)
- **Intensive margin:** To measure the impact of change in expenditure at channel type ($\Delta EX_j^{c,type}$) (purchase frequency fixed at the level in 2019)

3. Data

- Using household purchase data with demographic data collected from Macromill, Inc., which is Japanese survey company.
 - Macromill Holistic Spending Panel Survey (MHS)
- The dataset includes not only processed foods but also fresh foods, which are difficult to grasp with conventional POS data because they don't have barcodes.
- **Range**
 - Areas: Saitama, Chiba, Tokyo, and Kanagawa pref.
 - Time Span: Between March 9 and May 3, 2019 and 2020
 - Divided Period: March 9 to April 5 (Period1) and April 6 to May 3 (Period2) with measurements taken during the 28-day period immediately before and after the declaration of the state of emergency.

Descriptive Stat.: Expenditures in Period1(3/9–4/5)

Table 1: Expenditure(Period1: 3/9–4/5)

Group	Category	Online			Offline		
		Total (2020)	Total (2019)	Change (%)	Total (2020)	Total (2019)	Change (%)
Perishables	Diary products	90.6	72.1	25.62	1,991.5	1,743.9	14.2
	Fresh vegetables/fruits	207.5	151.4	37.1	4,749.4	4,440.7	6.95
	Meat/Ham/Eggs	98.1	109.5	-10.41	5,533.8	4,734.7	16.88
	Seasonings/Oil	80.3	67.6	18.69	1,717.4	1,456.2	17.94
	Tofu/Natto/Paste/ Pickles	50.2	56.4	-11	1,638.8	1,453.9	12.72
	Seafood	39.0	45.2	-13.71	2,139.3	1,886.6	13.4
Staple foods	Raw noodles/Cup noodles/Dried noodles	20.9	31.7	-34.1	1,765.1	1,341.4	31.59
	Rice/Grains/Cereals	193.3	165.6	16.73	1,468.5	1,239.3	18.49
	Powder	6.0	4.4	36.66	168.7	122.9	37.2
Storable foods	Retort pouches/ Cooking ingredients	80.8	69.9	15.6	1,426.3	1,101.0	29.55
	Frozen foods/ ingredients	331.3	294.5	12.48	1,624.3	1,279.6	26.94
	Canned foods/Dried foods	58.9	60.4	-2.51	833.1	640.4	30.09
	Alcoholic beverages	180.6	154.6	16.85	3,869.6	3,566.2	8.51
Total		1,437.6	1,283.5	12.01	28,925.7	25,006.7	15.67

Descriptive Stat.: Expenditures in Period2(4/6–5/3)

Table 2: Expenditures among Category/Channel(Period2: 4/6–5/3)

Group	Category	Online			Offline		
		Total (2020)	Total (2019)	Change (%)	Total (2020)	Total (2019)	Change (%)
Perishables	Diary products	107.6	78.4	37.19	2,214.4	1,808.0	22.48
	Fresh vegetables/fruits	205.1	161.4	27.06	5,651.3	4,563.2	23.84
	Meat/Ham/Eggs	159.0	113.7	39.81	6,242.9	4,773.5	30.78
	Seasonings/Oil	95.7	80.2	19.29	1,883.5	1,473.5	27.83
	Tofu/Natto/Paste/ Pickles	64.0	45.7	40.19	1,828.0	1,460.6	25.15
	Seafood	42.9	29.4	46.09	2,478.2	1,928.7	28.49
Staple foods	Raw noodles/Cup noodles/Dried noodles	50.9	27.7	83.29	1,793.4	1,354.9	32.36
	Rice/Grains/Cereals	274.8	154.5	77.84	1,295.1	1,287.1	0.62
	Powder	15.9	5.8	171.53	222.4	122.4	81.77
Storable foods	Retort pouches/ Cooking ingredients	67.1	53.4	25.63	1,338.2	1,107.2	20.86
	Frozen foods/ ingredients	338.0	292.5	15.54	1,627.9	1,316.5	23.66
	Canned foods/Dried foods	52.5	44.0	19.29	811.7	632.5	28.33
	Alcoholic beverages	238.3	163.0	46.17	4,471.5	3,881.9	15.19
Total		1,711.7	1,249.9	36.95	31,858.5	25,710.0	23.91

Comparison with Changes: 2020 vs. 2019 & Online vs. Offline

- Total offline spending was greater than online spending in period1
 - Consumers increased food spending to prepare for staying home
- Total spending were greater in Online than in Offline in Period2
 - To avoid going out, consumers increased spending in Online channel
- The change rates of purchases through Online channels increased in Period2, but the absolute values were smaller than those of Offline.
 - The use of Online may have increased in Period2, but it was relative.

4. Results

Perishables

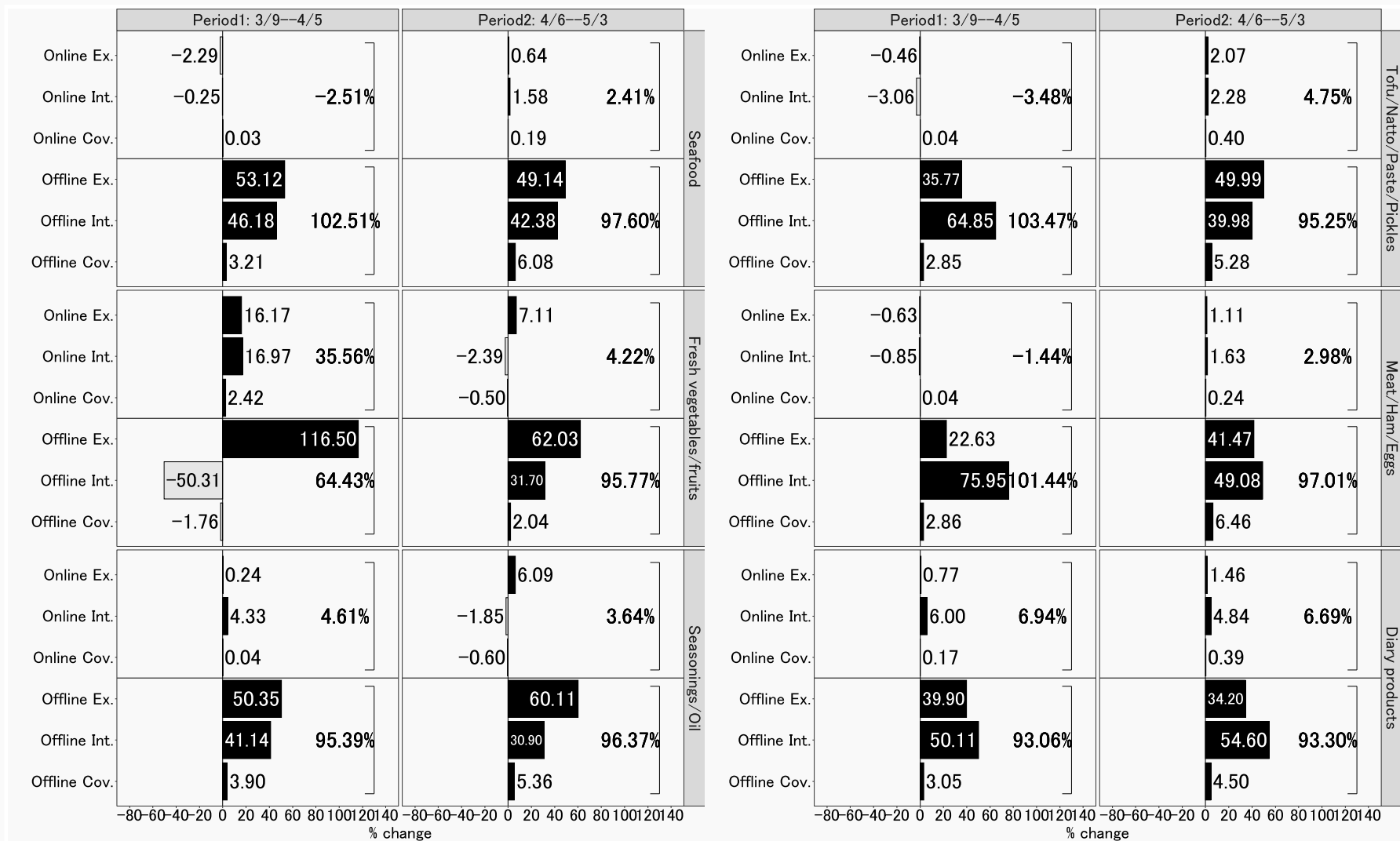


Figure 1: Contribution on Changes of Expenditure(Perishables)

- Although some perishable item categories in Online channels increased in period 2 compared to period 1, the magnitude of the contribution is small.
 - Consumers started to use online channels, but mainly use offline channel.
- In Period1, the value of either the Extensive or Intensive margin for Offline in Period1 is larger than the other.
- However, the differences between them were small in period 2.
 - Impact of eating at home on shopping style.
- In fresh vegetables/fruits, the contribution of online channels was large in period1, but it decreased steeply in period2. Instead, the contribution of offline channels increased.
 - In Period1, the Extensive margin in Offline was large and the Intensive margin had a negative value.
 - In Period2, the Intensive margin increased due to the increase in home dining opportunities.

Staple Foods

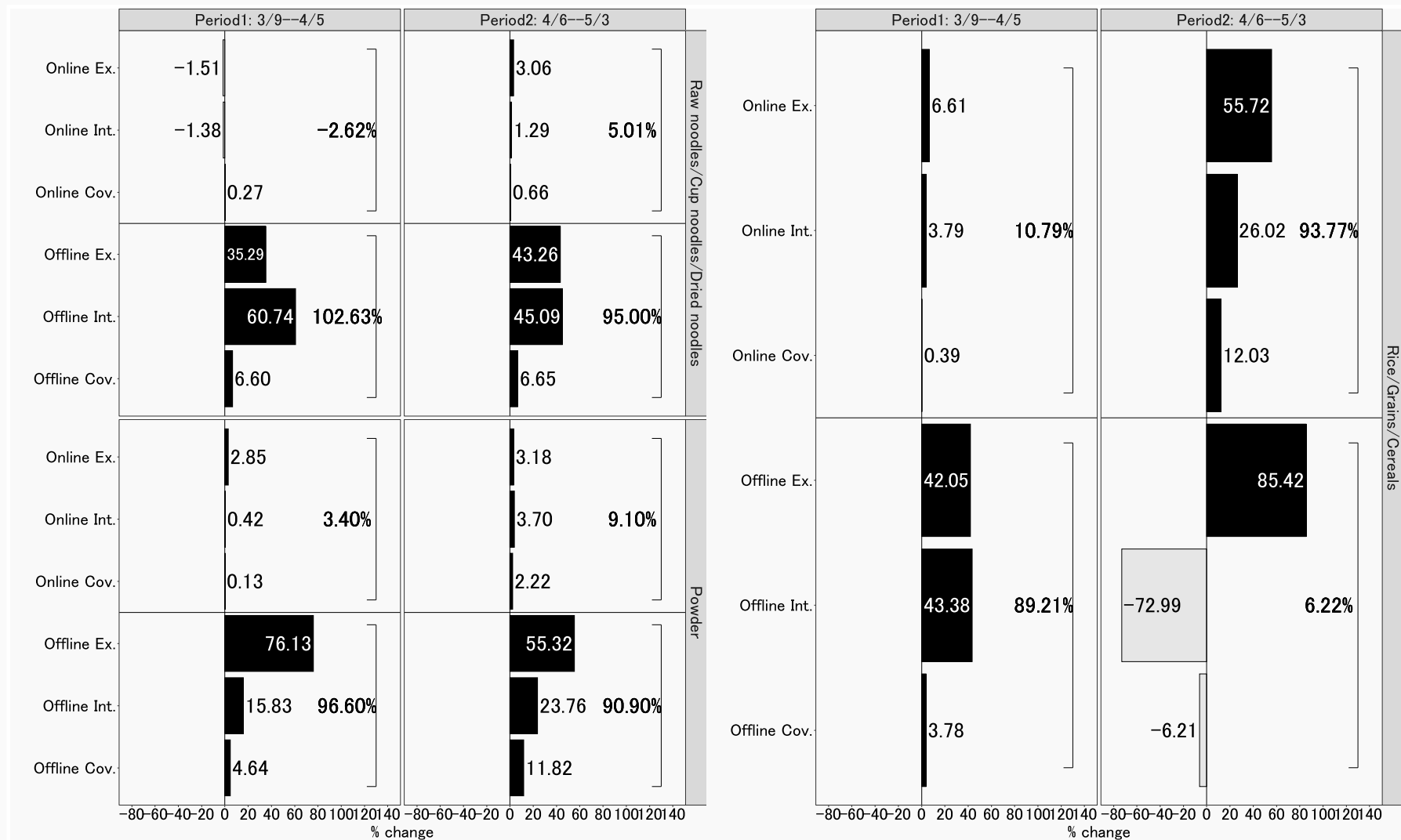


Figure 2: Contribution on Changes of Expenditure(Staple Foods)

- The contribution of Online channels increased in period 2 compared to period 1.
 - One of the drivers is the increase in demand for wheat products such as dried pasta.
- Rice/Grains/Cereals largely changed between Period1 and Period2.
- As the Extensive margin in Offline largely increased in Period2, the purchase frequency in 2020 increased compared to that in 2019.
- The trend of Intensive margin between 2019 and 2020 was different.
 - In Period2, the shopping styles were replaced from Offline to Online due to stay-at-home request.

Storable Foods

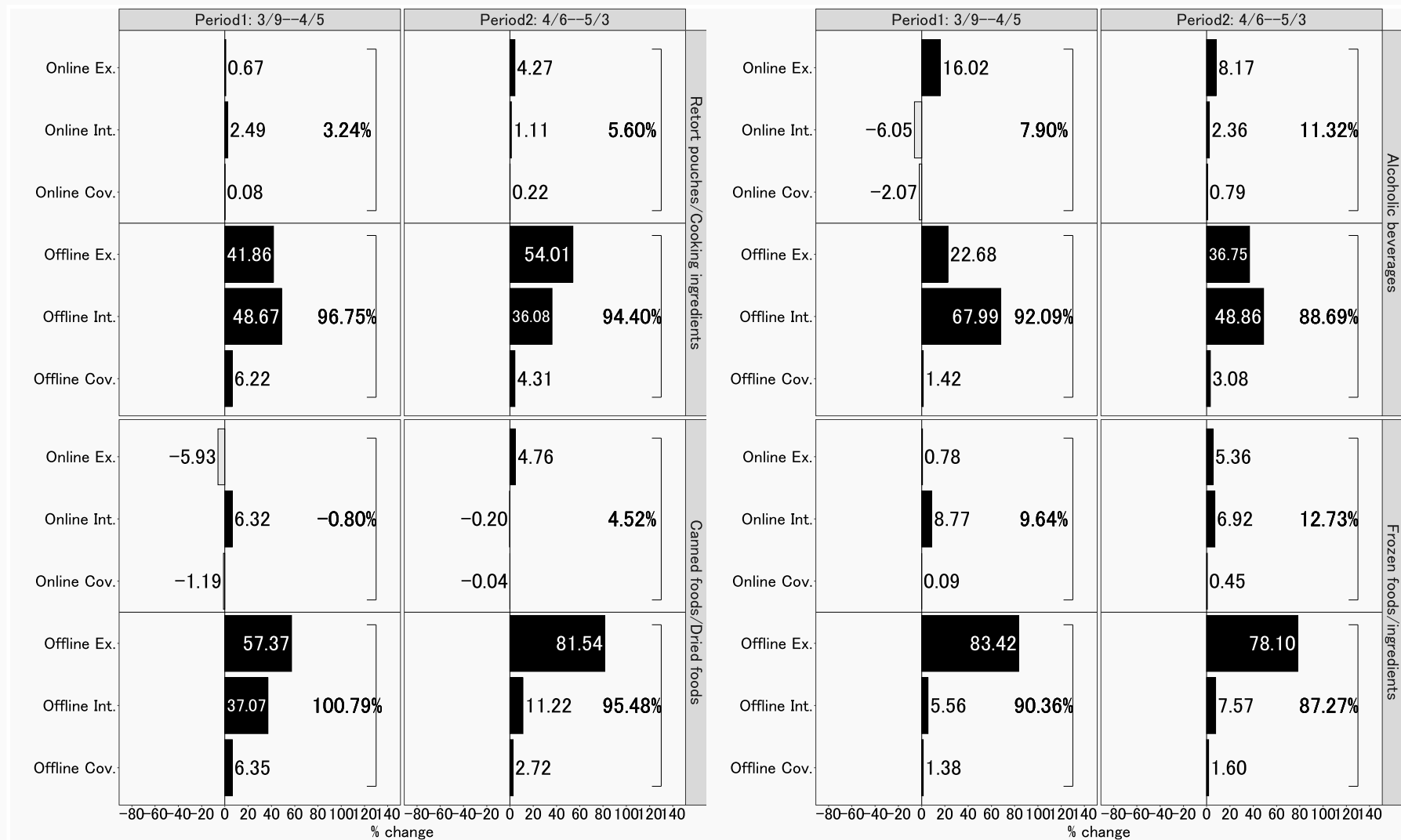


Figure 3: Contribution on Changes of Expenditure(Storable Foods)

- Contribution from online channels increased in Period 2 compared to Period 1.
- Items other than Frozen Foods/Ingredients increased the Extensive margin of Offline in Period2.
 - This means that the changes in expenditures on these items depends on the changes in purchase frequency.
- The results of staple and storable foods are similar, which meaning that the contribution of the Offline channel is larger than that of the Online channel.
- In contrast, the contribution of the Offline channel is larger than that of the Online channels for perishables.

5. Concluding Remarks

Overview of Results

1. It was common for people to purchase many items from Offline physical stores even during the semi-lockdown.
2. The contribution of offline channels was greater for perishables than for staples and storable foods.
3. Contribution of online channels was relatively high for staple and storable foods compared to perishables.
 - It depends on items whether Extensive margin increased or Intensive margin increased in each channel.
 - Consumers' habit of using offline channels was the strongest among the factors I hypothesized, except for some items.
 - Some consumers increased their use of online channels due to fear of COVID-19 infection, but the effect was probably limited.

- Since the dataset was aggregated by item categories and channels, I should use some econometric models that control for unobservable effects, such as household fixed effects, by using disaggregated data in the further step.
- These should be considered in future studies.
- The full version of this study has been published as Ito and Maruyama (2023) (in Japanese).

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