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# FEAR OF COVID-19 CONTAGION: THE IDIOSYNCRATIC EFFECTS OF AN AGGREGATE PANDEMIC SHOCK

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# Fear of COVID-19 Contagion: The Idiosyncratic Effects of an Aggregate Pandemic Shock*

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**Abstract**

We examine how the fear of COVID-19 contagion influences consumer expenditure patterns. We show that the consumption expenditure responses to the spread of the COVID-19 pandemic are significantly heterogeneous across generations. We find that the elderly spend less than the younger generation by at least 5% as COVID-19 spread. In fact, those aged above 60 significantly decreased their spending even on food and drink products by 13%. We also find that the elderly forgo shopping in favor of the younger generation. These heterogeneous responses are likely to be due to the fear of the COVID-19 infection.

*JEL Classification:* D12; E21

*Keywords:* COVID-19; consumption gap across generations; expenditure; fear; spending behavior

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# 1 Introduction

How does the COVID-19 pandemic influence consumption expenditure? We show that the response to the spread of COVID-19 has been significantly heterogeneous across generations in Japan. We find that the consumption expenditure of the elderly is negatively associated with the number of new COVID-19 cases: the elderly spend less than the younger generation by at least by 5% as COVID-19 spread throughout the country. In fact, those aged above 60 significantly decreased their spending even on food and drink products by 13%. We also find that the elderly forgo shopping to the younger generation. These heterogeneous responses are likely to be due to the fear of COVID-19 infection. The findings suggest that heterogeneous perceptions about fear of health-related consequences transform an aggregate shock into an idiosyncratic one.

A COVID-19 shock is interpreted as an aggregate shock. Figure 1 suggests a COVID-19 shock is a purely exogenous one, with a severe impact on aggregate demand. In fact, gross domestic demand in Japan fell sharply by more than 57 trillion yen from 2019Q3 to 2020Q2. The figure has been that the magnitude of this effect on the gross domestic product (GDP) is larger than that of the global financial crisis in 2009. The world economy experiences a similar pattern. Specifically, the IMF (2021) reports that world output in 2020 declined sharply by $-3.5\%$ year-on-year. The decline is more severe by $-0.1\%$ than that of the global financial crisis in 2009. The evidence supports the view that a COVID-19 is an aggregate shock to the global economy.

Looking at consumption expenditure, there are four mechanisms to explain the responses of consumption expenditure to the COVID-19 pandemic (Immordino et al., 2021): (1) the suspension of many production and commercial activities on the supply side; (2) a negative income shock, which is not covered by compensated by government transfers; (3) increased precautionary savings due to increased uncertainty about future earnings, current and future employment status, credit conditions, and uncertainty about the length of the pandemic; and (4) an infection-concern motive, that is, the response to the risk of contracting the virus. Mechanisms (1)–(3) can be interpreted as aggregate shocks, while (4) can be classified as an idiosyncratic shock. The COVID-19 pandemic obviously works as an aggregate shock. As for (1) the suspension of many production and commercial activities on the supply side, Cavallo (2020), for example, shows that consumers in the United States have been spending relatively more on food and relatively less on transportation and other categories during the COVID-19 pandemic. The production suspension on the supply side can be thus interpreted

as an aggregate supply shock. As for (2) a negative income shock, the literature suggests that negative income shocks that are not insured have considerable impacts on spending (Baker et al., 2020; Coibion et al., 2020; Kubota et al., 2021).[1] As the standard model predicts, the expenditure responses to an aggregate (negative) demand shock differ between consumers with and without liquidity-constraints. As for (3) increased precautionary savings, Cox et al. (2020) and Immordino et al. (2021) show a drastic increase in savings during the pandemic. Specifically, Cox et al. (2020) discuss that the pandemic shock increased the aggregate uncertainty about future earnings, job status, and the length of the pandemic. This suggests that an aggregate uncertainty shock induces consumers to increase precautionary savings. While the spending responses are heterogeneous among consumers, the original source of the responses stems from aggregate shocks: (1) an aggregate supply shock, (2) an aggregate demand shock, and (3) an aggregate uncertainty shock.

As for (4) an infection-concern motive, the growing literature suggests that the fear of the COVID-19 pandemic plays an important role in explaining the effects of lockdown orders or voluntary lockdowns on personal mobility and interactions.[2] Alexander and Karger (2021), Alfaro et al. (2020), Barrios et al. (2021), Cicala et al. (2020), Goolsbee and Syverson (2021), Watanabe and Yabu (2021a), and Watanabe and Yabu (2021b) use location data from smartphone devices to quantify the impact of the fear of contagion on consumer choices. While the literature suggests the overall relationship between the fear of infection and consumer choices, the fear of the infection has potentially heterogeneous effects on expenditure among generations in terms of in-person shopping, eating out, and traveling. However, there is scant evidence that the fear of contagion has heterogenous impacts on actual expenditures.[3]

[1]For example. Baker et al. (2020) and Coibion et al. (2020) examine whether the consumption responses to the 2020 economic stimulus payments are heterogeneous among consumers in the United States. Kubota et al. (2021) identify the heterogeneity of spending among Japanese consumers.

[2]Binder (2020) shows that fear influences the macroeconomic expectations of consumers by focusing on the effects of fear as an aggregate shock on macroeconomic expectations.

[3]Goolsbee and Syverson (2021) show that the fear of infection during the COVID-19 pandemic is important to explain heterogeneous choice behaviors among consumers using mobile location data. However, they do not examine the effect of the fear of infection on actual expenditure. Watanabe and Yabu (2021a) and Watanabe and Yabu (2021b) show that the elderly refrained from going out more than the young in response to the information about the pandemic, while they do not examine the heterogenous effects of (voluntary) lockdowns on consumption expenditures. To the best of our knowledge, the only exception is Immordino et al. (2021), who examine the overall relationship between the fear of contagion and consumption behavior. They show that the probabilities of consumption decreases and savings increases are positively associated to the fear of contagion, particularly for shopping, eating out, and traveling.

This study fills this research gap. In contrast to the literature, we focus on the idiosyncratic reactions of actual expenditure to the fear of the COVID-19 pandemic. The infection-concern motive corresponds to the risk of contracting the virus. It is well known that the probability to become severely ill by COVID-19 infection increases with age. Therefore, fear of contagion must be heterogeneous across generations and work as an idiosyncratic shock. Based on a granular data source, this study provides a detailed analysis and determines how the fear of the COVID-19 pandemic as an idiosyncratic shock affects consumer expenditure. The evidence suggests that the fear of infection actually becomes an idiosyncratic shock among the older generation . That is, an idiosyncratic shock that stems from the infection-concern motive generates heterogeneous responses in consumption behavior. In fact, the elderly significantly decrease expenditure and forgo shopping to the younger generation due to fear of COVID-19 contagion. This suggests that the heterogeneous perceptions about the fear of infection transform an aggregate shock into an idiosyncratic one for any novel infectious disease.

The remaining of the paper is organized as follows: Section 2 presents the survey data we use. Section 3 shows the development of expenditure before and after COVID-19. Section 4 explain the tests we use to verify whether the fear of COVID-19 infection influences consumption expenditure and Section 5 shows the results. Section 6 examines whether the fear of COVID-19 infection influences the frequency of consumer visits at retail stores. Section 7 concludes the paper.

# 2 Data

## 2.1 Data about the consumption expenditure

We use panel data (SCI-personal) on consumption expenditure collected by a marketing company, Intage. Specifically, we use day-to-day shopping information collected on an ongoing basis from consumers aged 15–79 all over Japan. The Family Income and Expenditure Survey (FIES) conducted by the Statistics Bureau of Japan records the consumption expenditure of approximately 6,000 households based on household heads, while the panel data we use records individual expenditure for more than 50,000 consumers. The data capture the profile of these consumers in detail, including aspects such as income, education, and financial assets. Specifically, we can determine who bought what, when, where, how many, and

at what price. These data cover items that households purchase frequently, such as food (except for fresh food, prepared food, and lunch boxes), beverages, daily miscellaneous goods, cosmetics, pharmaceutical products, and cigarettes.[4][5] We use the data to test whether the elderly decreased their expenditure due to the fear of COVID-19 compared to the younger generation.

There are two caveats in the data on consumption expenditure.[6] First, from Table 2, women outnumber the men. As in Kaplan and Schulhofer-Wohl (2017) and D'Acunto et al. (2021), our data also show that the expenditure by women is larger than that of men. Second, the coverage of the data relative to Japanese households' consumption is not large . Diamond et al. (2020) use SCI-personal and report that the items included in the data cover approximately 30% of the weight of the Japanese Consumer Price Index.[7]

## 2.2 Survey on the effects of COVID-19 pandemic on daily life

Intage Inc. surveys the effects of the COVID-19 pandemic on daily life from October 23 to November 4, 2020. A total of 35,389 respondents out of 83,501 completed the online-survey. The response rate is 42.4%. The median time to take the survey was 4.3 minutes.

The survey contributes to identifying how the fear of COVID-19 influences consumption expenditure across generations. First, the survey can be matched with the survey on household expenditure. In fact, more than half of those who took the survey are also respondents to the survey on household expenditure in Subsection 2.1. We successfully match the two survey data for 29,864 respondents. The matched data allow us to examine the heterogeneous responses of consumption expenditure during the COVID-19 pandemic.

Second, the survey allows us to identify who idiosyncratic shocks due to the COVID-19 pandemic.[8] It requires respondents to provide information about changes in their daily lives. Questions (1)–(17) about work or school identify changes in employment status and income level, how one works (at the office or at home), office (school) closure, and office (school) reopening. The answers to the questions are interpreted as shocks that each respondent faces

[4]Because our scanner data cover daily necessities, they do not cover housing, utilities, durables, clothing, and services.

[5]Table 2 shows the descriptive statistics of the data from January to July 2020.

[6]O'Connell et al. (2021) also use household scanner data similar to the data we use.

[7]D'Acunto et al. (2021) use similar scanner data from U.S. households, and report that the scanner data cover around 25% of the US households' consumption.

[8]The survey questionnaire is presented in Appendix A.

due to the COVID-19 pandemic. Because the COVID-19 pandemic is completely exogenous and has heterogeneous effects, the identified changes in employment status, income level, and office closure are idiosyncratic shocks. To focus on the heterogeneous effects of consumption expenditure to the fear of COVID-19, the identified shocks are vital for controlling idiosyncratic shocks such as unemployment and income shocks.[9]

Third, the survey identifies how respondents live during the COVID-19 pandemic. Respondents are required to provide information about how they respond to COVID-19. For example, the survey asks them to provide information about changes in opportunities to eat out, cook at home, and take trips. The information reflects the endogenous responses of respondents to idiosyncratic shocks and the policy interventions in response to the COVID-19 pandemic. Furthermore, the survey asks respondents to provide information about how their family members who live with them change their lives in response to COVID-19. Therefore, we can use information on not only the respondents but also their family members as a set of comprehensive covariates to control for the endogenous reactions to shocks and the policies that may influence the consumption level.[10]

# 3 Household expenditure before and after the COVID-19 pandemic

Figure 2 shows the chronological development of expenditure before and during the COVID-19 pandemic. There are two spikes in expenditure from 2019 to 2020. First, there is a peak and a trough before and after the consumption tax hike in October 2019.[11] The expenditures increase by approximately 15% in September 2019 compared to the previous month and then fell sharply by more than 5%. This reflects the typical responses of household expenditure to the consumption tax hike, as was also case for the tax hike in April 2014.[12]. Second, the expenditure increased by more than 5% in February 2020. Starting in late February, signs of

[9]Tango and Nakazono (2021) examine how unemployment and (positive/negative) income shocks affect consumption expenditure during the COVID-19 pandemic using the same survey.

[10]The descriptive statistics are presented in Table B.1 in Appendix B.

[11]In Japan, the consumption tax rates increased from 8% to 10% on October 1, 2019. Tax reduction rates apply to food and other daily necessities. Therefore, the tax on services and products other than food and other daily necessities increased.

[12]Cashin and Unayama (2016) also find a peak and a trough before and after the consumption tax hike in April 2014.

an epidemic were detected in some areas, especially in Hokkaido. As shown in Table 1, the government of Japan announced the basic policy measures for COVID-19 on February 25, 2020. On the next day, the governor of Hokkaido Prefecture requested public elementary and junior high school to close in response to a rapid increase in the number of COVID-19 cases in the prefecture. The responses to the policy interventions seem to induce households to forgo going out and eating out and to subsequently *increase* expenditure for cooking at home, as reflected in Figure 2.

However, Figure 3 suggests that the development of the expenditure by generation changed drastically after April 2020. First, the expenditure diverges in April 2020, when the nationwide state of emergency was declared. The expenditure levels increased by approximately 7% in February and March 2020 compared to January 2020 for all generations. However, they diverge in April 2020: while those aged below 40 significantly increased their expenditure, those aged 70 or above sharply decreased their expenditure. In fact, the expenditure of the consumers in their 20s surged at 115, while that of those in their 70s reduced to 102 in April. The difference reaches 18% at most. Figure 3 illustrates that the changes in expenditure are predicted by age. The fact that the younger spend more and the elderly less may suggest that the fear of the COVID-19 pandemic entails this expenditure gap between generations. Second, the increase and decrease in the expenditure gaps repeat three times with the increase in the number new COVID-19 cases. Figures 3 suggests that the change in the expenditure gaps and the new COVID-19 cases comove. In fact, while the gap decreases after lifting the nationwide state of emergency in late May, an increase in the number of new COVID-19 cases in late July seems to widen the expenditure gap. This is the case after September 2020. While the gap temporally diminished in September, there is a divergence between generations along with an increase in the number of new COVID-19 cases in late October. The evidence that the divergence of expenditures between generations is associated with the new COVID-19 cases may support the view that fear of contagion are heterogeneous across generations and work as an idiosyncratic shock.

Note that the government of Japan never prohibited people from going out, even during the state of emergency.[13] While the government of Japan declared the state of emergency in April 2020, it only asked for people to exercise self-restraint from non-essential outings. In response to calls to close their business during the state of emergency, large scale retailers such as department stores and shopping malls stopped their operations. However, several

[13]Throughout 2020, the government of Japan declared a state of emergency only in April.

restaurants and retailers such as grocery stores, supermarkets, and drug stores remained open during the state of emergency. Furthermore, the government of Japan never imposed a lockdown; transportation services such as train, bus, and subway were provided as usual. This means that the elderly, as well as the younger generation, were free to go shopping anytime and anywhere they wanted to even during the state of emergency. In spite of that, if the elderly forgo shopping to the young, this is most likely due to the fear of COVID-19 infection. The following section verifies whether this fear influences the spending of the elderly.

# 4 Estimation strategy

This section formally tests whether the elderly decreased their expenditure due to the fear of COVID-19 compared to the younger generation. To this end, we estimate the following equation based on a dynamic difference-in-differences (DDID) approach:

$$\begin{aligned}\ln \frac{Cons_{i,t}}{Cons_{i,t-12}} =& \alpha \times D^{Elderly} + \sum_j \beta_j \times D^{Month_j} \\ &+ \sum_j \gamma_j \times D^{Month_j} \times D^{Elderly} + \mathbf{X}\delta_{\mathbf{x}} + \mathbf{Y}\delta_{\mathbf{y}} + \varepsilon_{\mathbf{i,t}},\end{aligned} \tag{1}$$

where $Cons_{i,t}$ is the (nominal) consumption expenditure of individual $i$ in month $t$. $D^{Elderly}$ is a dummy variable that takes 1 when individual $i$ is 60 or above, and 0 otherwise. $D^{Month_j}$ and $\mathbf{X}$ are a calendar (month) dummy variable and control variables such as fixed effects, gender, income, educational attainments, family size, and new cases of COVID-19 at the prefecture level in Japan. Our interest is in the coefficient $\gamma$ on the cross-term between $D^{Month}$ and $D^{Elderly}$. A positive $\gamma$ suggests that the elderly spend more than the young, and vice versa a negative $\gamma$.

Here, $\mathbf{Y}$ is a set of COVID-19-oriented shocks constructed from the survey in Appendix A. We use 16 (eight by two) dummy variables and one categorical variable from the respondent and the family members who live with the respondent, respectively. The dummy variables for the respondent and the family members are $D_t^{Unemployment}$, $D_t^{GettingJob}$, $D_t^{SchoolClose}$, $D_t^{SchoolReopne}$, $D_t^{IncreaseEatout}$, $D_t^{DecreaseEatout}$, $D_t^{IncomeUp}$, and $D_t^{IncomeDown}$. The categorical variables measure how often the respondent and the family members work from

home.[14] These variables allow us to control for the potential effects on the consumption expenditure of school closure, change in employment status, positive and negative income shocks, and the frequency of eating out. Therefore, estimating Equation (1) identifies the elderly's fear effect on consumption expenditure.

# 5 Results

First, we show the results for all products. Figure 4 shows the developments of the $\gamma$ coefficient using January 2020 as 0.[15] The figure shows that the monthly expenditure of the elderly in 2020 is negatively correlated to the number of new COVID-19 cases. The expenditure of the elderly does not differ from that of consumers below 60 up to March 2020. However, they spent less by approximately 5% compared to those aged below 60 during April and May, when the government declared the state of emergency. Once the government lifted the state of emergency, in June, the expenditure of the elderly recovered. However, the cycle repeats after June. That is, the expenditure of the elderly fell again by 5% in August and bounced back in October.[16]

We also estimate Equation (1) using a subsample from food and drink products and products other than food and drink. Figure 5 supports the view that the elderly spend less than those aged less than 60. The top and bottom panels present the $\gamma$ coefficients using the subsample of food and drink products and the others, respectively. The top panel shows significant drops in the expenditure of the elderly of more than 10% in April, May, and August, compared to January. The impact is at most 13%; those aged above 60 significantly decreased their spending even on food and drink products by 13% in May, compared to January. This is also the case in the bottom panel using a subsample of products other than food and drink. While the decrease in the expenditure of the elderly is insignificant, the bottom panel shows that their expenditure decreases in April and August compared to

[14] We define the dummy variables in Appendix A. The categorical variables regarding working from home take 1, 2, or 3 when a respondent answers "YES" to Questions (13), (14), or (15) in Survey (I) for her/himself and in Survey (II) for the family members, respectively.

[15] Table B.2 summarizes the estimation results by estimating Equation (1). Figures (4)–(6) and Figures (B.1)–(B.3) in Appendix B depict the development of main coefficient $\gamma$ on the cross-terms between the month dummies and $D^{Elderly}$.

[16] The above results are robust when we set March, June, and October as base months in Figure B.1. The figure shows that the expenditure of the elderly significantly fell by more than 5% in April, May, and August.

January.[17]

We check the robustness of the results using multiple age dummies in the following equation:

$$\ln \frac{Cons_{i,t}}{Cons_{i,t-12}} = \sum_j \beta_j \times D^{Month_j} + \sum_k \gamma_k \times D^{Cohort_k} + \sum_k \sum_j \gamma_{k,j} \times D^{Month_j} \times D^{Cohort_k} + \mathbf{X}\delta_{\mathbf{x}} + \mathbf{Y}\delta_{\mathbf{y}} + \varepsilon_{\mathbf{i,t}},$$

where $D^{Cohort_k}$ is a dummy variable that takes 1 when individual $i$ belongs to cohort $k$, and 0 otherwise.[18] $D^{Month_j}$ and $\mathbf{X}$ are a calendar (month) dummy variable and control variables such as fixed effects, gender, income, educational attainments, and family size, respectively. $\mathbf{Y}$ is a set of COVID-19-oriented shocks constructed based on the survey in Appendix A. Our interest is in the $\gamma$ coefficient on the cross-term between $D^{Month}$ and $D^{Cohort_6}$ and $D^{Cohort_7}$ for those in their 60s and 70s. A positive $\gamma$ suggests that those in their 60s and 70s spend more than the younger generation, while a negative $\gamma$ means that they spend less.

Figure 6 supports the view that the elderly spend less than the young. The top and bottom panels present the coefficients $\gamma$ on the interaction terms between the month dummies and $D^{Cohort_6}$ and $D^{Cohort_7}$ for those in their 60s and 70s for all products. Both panels show a significant drop in the expenditure of the elderly by approximately 5% in April, May, and August, compared to January. Furthermore, Figure 6 suggests that in their 70s spend less than those in their 60s. The results support the view that more elderly consumers decreased their consumption expenditure relatively more probably due to the fear of the COVID-19 pandemic.[19]

We check the robustness of the results using another survey about COVID-19 which was conducted in late March to early April 2020. Intage Inc. surveys the effects of the COVID-

[17]The above results are robust when we set March, June, and October as base months in Figure B.2. The figure shows that the expenditure of the elderly significantly fell by more than 10% in May and August when the subsample of food and drink products is considered.

[18]$D^{Cohort_k}$ is a dummy variable at 10-year intervals starting for those in their 20s. Specifically, a set of $D^{Cohort_k}$ $(k = 2, 3, 5, 6, 7)$ corresponds to those in their 20s, 30s, 50s, 60s, and 70s, respectively. Therefore, $D^{Cohort_4}$ for those in their 40s is set as a base dummy.

[19]The above results are robust when we set March, June, and October as base months in Figure B.3. The figure shows that the expenditure of the elderly significantly fell as COVID-19 spread. The results are robust when the consumption measures are adjusted using the same equivalence scale as in Banks et al. (1998), although we do not report the regression results due to space considerations.

19 pandemic on daily life after infection spread from 31 March to 7 April 2021.[20] The survey contributes to directly identifying how respondents fear in response to the onset of the spread of COVID-19. The survey asks respondents to answer how you are concerned about the spread oc COVID-19.[21] We successfully further match the former survey conducted in October with this survey conducted in late March for 25,192 respondents. The matched data allow us to examine the relationship between fear of COVID-19 and consumption expenditure in the onset of the COVID-19 pandemic.[22] We estimate the following equation using a dummy variable $D^{Fear}$:

$$\begin{aligned}\ln \frac{Cons_{i,t}}{Cons_{i,t-12}} =& \alpha \times D^{Fear} + \sum_j \beta_j \times D^{Month_j} \\ &+ \sum_j \gamma_j \times D^{Month_j} \times D^{Fear} + \mathbf{X}\delta_{\mathbf{x}} + \mathbf{Y}\delta_{\mathbf{y}} + \varepsilon_{\mathbf{i,t}}.\end{aligned} \tag{2}$$

A positive $\gamma$ suggests that those who fear COVID-19 spend more, while a negative $\gamma$ means that they do less. Figure 7 shows the developments of the $\gamma$ coefficient using February 2020 as 0. The figure shows that the monthly expenditure of those who fear COVID-19 is negatively correlated to the number of new COVID-19 cases. The expenditure of those who fear COVID-19 does not differ from those who do not up to March 2020. However, they spent less by approximately 5% compared to those who do not fear COVID-19 during April, May, and June when the government declared the state of emergency.[23] The results support the view that consumers who fear COVID-19 decreased their consumption expenditure relatively more.

[20] A total of 33,563 respondents out of 75,431 completed the online-survey. The response rate is 44.5%.

[21] The survey asks what to extent respondents are concerned about the COVID-19. Respondents choose the most appropriate one from (1) feel very concerned; (2) feel concerned; (3) feel a little concerned; (4) can't say either; (5) not feel too concerned; (6) not feel concerned; (7) not feel concerned at all. Based on the answer to the survey, we construct a dummy variable $D^{Fear}$ which takes 1 when a respondent chooses (1), (2), or (3), and 0 otherwise. The sample mean of $D^{Dear}$ is approximately 92.2%.

[22] In what follows, we assume that the fear of COVID-19 which is identified using the survey in March 2020 is time-invariant at least for the subsequent three months from April to June 2020.

[23] The above results are robust when we set March as a base month, although we do not report the regression results due to space considerations.

# 6 Frequency of visiting retail stores

The fact that the elderly spend less as the number of new COVID-19 cases increases suggests they may forgo going out due to an increase due to fear of infection. If so, the elderly generally go shopping with a lower frequency during the COVID-19 pandemic. To formally test whether the frequency of shopping at retail stores decreased as COVID-19 spread, we estimate the frequency of visits at retail stores for each consumer.

The transaction-level scanner data on consumption expenditures allow us to count how frequently consumers visit stores per month. As explained in Section 2.1, SCI-personal records when and where respondents purchase on a daily basis. This means we can estimate how often respondents visit retail stores per month.[24] We count the number of stores where respondent $i$ goes shopping during day $d$ in month $t$, $Visit_{i,d,t}$. We sum up $Visit_{i,d,t}$ for each month from January to December 2020.[25] Therefore, $Visit_{i,t}$ is the estimated number of visits at retail stores by individual $i$ in a month.

To examine whether the elderly visit retail stores less compared to the younger generation, we estimate the following equation:

$$\begin{aligned}\ln \frac{Visit_{i,t}}{Visit_{i,t-12}} =& \alpha \times D^{Elderly} + \sum_j \beta_j \times D^{Month_j} \\ &+ \sum_j \gamma_j \times D^{Month_j} \times D^{Elderly} + \mathbf{X}\delta_{\mathbf{x}} + \mathbf{Y}\delta_{\mathbf{y}} + \varepsilon_{\mathbf{i,t}},\end{aligned} \tag{3}$$

where $Visit_{i,t}$ is the frequency of retail stores visits by individual $i$ in month $t$. Similar to Equation (1), $\mathbf{X}$ are a calendar (month) dummy variable and control variables such as fixed effects, gender, income, educational attainments and family size and $\mathbf{Y}$ is a set of COVID-19-oriented shocks. Our interest is in the $\gamma$ coefficient on the cross-term between $D^{Month}$ and $D^{Elderly}$. A positive $\gamma$ suggests that the elderly spend more than the young, and vice versa for a negative $\gamma$.

Figure 8 presents the development of the $\gamma$ coefficient using January 2020 as 0. The figure shows that the monthly visits of the elderly are negatively correlated to the new COVID-19 cases in 2020. However, the frequency of visits at retail stores by the elderly is not

[24]The survey we use includes data from online shopping. Our estimation results are robust when expenditures and the frequency of visits to retail stores from online shopping are excluded, although these are not reported to save space. Using the same data we use, Tsukawaki et al. (2021) estimate that approximately 13% of expenditure is from online shopping.

[25]Table 2 in Appendix B shows the descriptive statistics for the frequency of visits at retail stores.

different from those of consumers aged below 60 up to March 202. The number of visits then reduced by 4% compared to those aged below 60 in April and May, when the government declared the state of emergency. Once the government lifted the state of emergency, the frequency of visits by the elderly recovered by June. However, the cycle repeated after June. That is, the expenditure of the elderly fell again by 4% in August, bouncing back in October.[26]

Figure 8 supports the view that the elderly visit stores less than the younger generations during the COVID-19 pandemic. The evidence of infrequent visits to retail stores by the elderly suggests that the heterogeneous expenditure responses are likely to be due to fear of the COVID-19 infection: the elderly may forgo shopping to the young. This finding implies that the heterogeneous perceptions of the fear of health-related consequences transforms an aggregate shock into an idiosyncratic one for any novel infectious disease.

# 7 Conclusions

This study examines how the spread of COVID-19 influences the consumption expenditure of Japanese households. Using large-scale monthly panel data collected from more than 50,000 Japanese households, we examine how consumption expenditure changes from before and to after the onset of COVID-19. We show that the response to the spread of COVID-19 is significantly heterogeneous across generations. We also find that, during the state of nationwide emergency, the consumption expenditure of the elderly significantly decreased compared to before and to that of the younger generations. In fact, those aged above 60 significantly decreased spending even on food and drink products by 13%. Further, the elderly forgo shopping to the young, likely due to the fear of COVID-19 contagion. The evidence suggests the heterogeneous perceptions of the fear of health-related consequences transform an aggregate pandemic shock into an idiosyncratic one for any a novel infectious disease.

[26]The above results are robust when we set March, June, and October as base months in Figure B.4. The figure shows that the frequency of visits by the elderly significantly fell approximately by 5% in May and August.

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Table 1: Chronological developments surrounding COVID-19 and the state of emergency in 2020

| Date | News and policy announcements in response to COVID-19 |
|---|---|
| January 16, 2020 | Announcement of the first infected individual in Japan. |
| January 28, 2020 | Announcement of the first infected Japanese. |
| January 30, 2020 | The government of Japan established the Novel Coronavirus Response Headquarters (NCRH). |
| February 5, 2020 | Quarantine on the Diamond Princess. |
| February 25, 2020 | NCRH announced the government's basic policy for COVID-19. |
| February 26, 2020 | Public elementary and junior high school closure requests in Hokkaido. |
| February 27, 2020 | Prime Minister Abe requests schools nationwide to close temporarily. |
| March 9, 2020 | Expert meeting presents "three conditions" for a high risk of infection. |
| March 12, 2020 | WHO certified the outbreak as a "pandemic." |
| March 25, 2020 | Governor of Tokyo Koike requests staying at home on weekends. |
| April 3, 2020 | The number of infected people worldwide exceeds 1 million. |
| April 7, 2020 | The government announced a state of emergency in seven prefectures. |
| April 16, 2020 | The government expands the state of emergency nationwide. |
| April 18, 2020 | The number of infected people in Japan exceeds 10,000. |
| April 20, 2020 | Economic policy: JPY 100,000 to be paid to all citizens. |
| May 4, 2020 | The government decides to extend the state of emergency until May 31, 2020. |
| May 21, 2020 | The government changes the area for the emergency state. |
| May 22, 2020 | An emergency meeting of the Bank of Japan Policy Board (eliminate the prospect of JGB holdings). |
| May 25, 2020 | The government lifts the state of emergency. |

Table 2: Descriptive statistics of household expenditure and frequency of visits at retail stores. Source: Intage Inc .

| | Purchase amount | | frequency of visits | | Observations |
|---|---|---|---|---|---|
| | Mean | Median | Mean | Median | |
| All | 22,521 | 18,923 | 21.337 | 20.000 | 727,853 |
| Female | 27,139 | 24,104 | 21.381 | 20.000 | 421,202 |
| Male | 16,761 | 13,300 | 21.276 | 19.000 | 306,651 |
| High school graduate or below | 24,599 | 21,103 | 21.662 | 20.000 | 190,811 |
| Four-year college graduate or above | 20,752 | 16,888 | 21.397 | 19.000 | 310,357 |
| Household annual income below JPY 4 million | 20,928 | 17,741 | 20.853 | 19.000 | 207,102 |
| Household annual income of at least JPY 7 million | 24,330 | 20,212 | 21.934 | 20.000 | 25,0695 |
| Age 20–29 | 12,626 | 9,002 | 15.593 | 13.000 | 74,280 |
| Age 30–39 | 19,826 | 16,590 | 19.811 | 18.000 | 141,699 |
| Age 40–49 | 24,535 | 21,160 | 22.596 | 21.000 | 182,028 |
| Age 50–59 | 26,194 | 22,500 | 24.039 | 22.000 | 154,416 |
| Age 60–69 | 26,744 | 23,250 | 22.928 | 21.000 | 108,683 |
| Age 70–79 | 24,883 | 21,793 | 20.320 | 18.000 | 56,935 |

Note: The data are from January 2019 to December 2020.

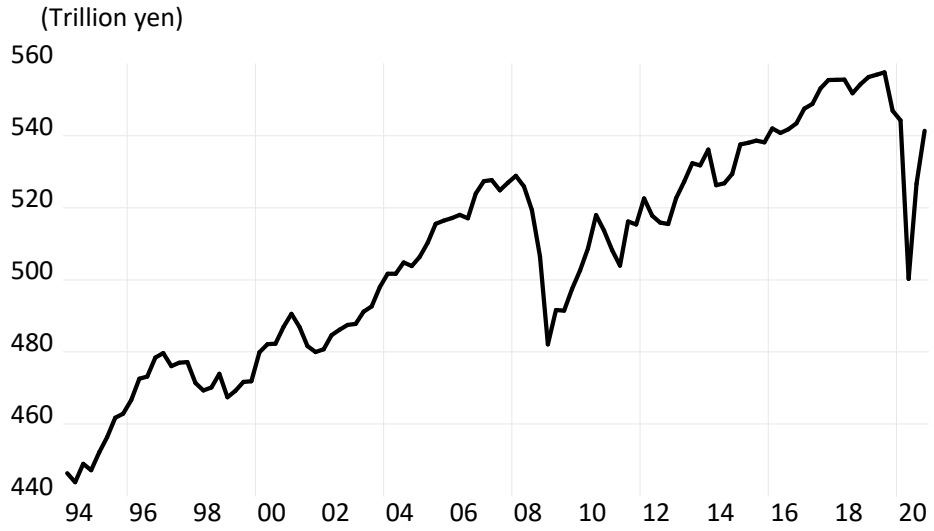


Figure 1: Development of GDP from 1994 to 2020 in Japan. Source: Cabinet Office, the Government of Japan .

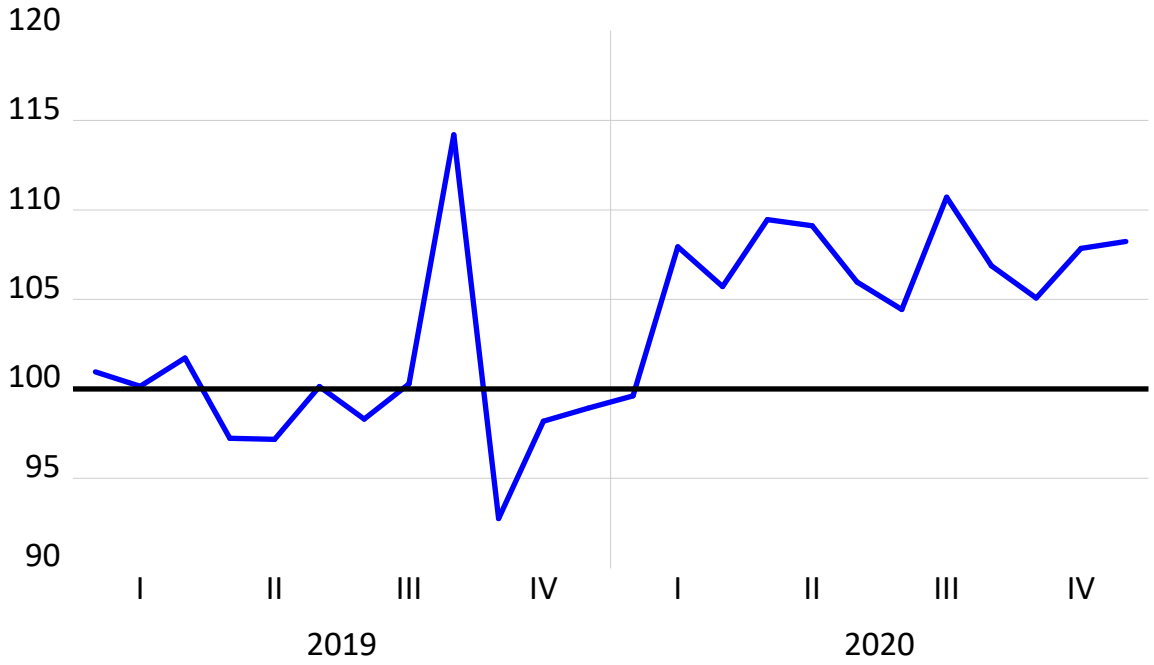


Figure 2: Development of expenditure from January 2019 to December 2020. The series are seasonally adjusted and standardized using the average expenditure from January 2019 to December 2019 as 100%.

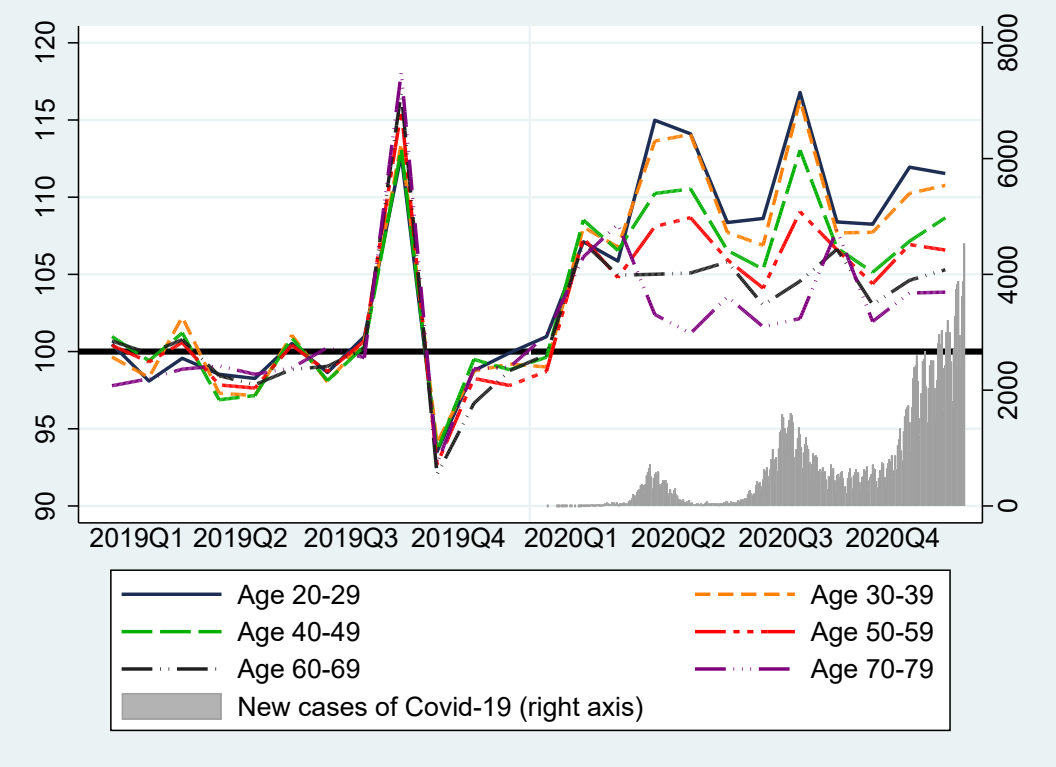


Figure 3: Development of expenditure by ages (left axis) and new cases of COVID-19 (right axis) from January 2019 to December 2020. The series of expenditure are seasonally adjusted and standardized using the average expenditure from January 2019 to December 2019 as 100.

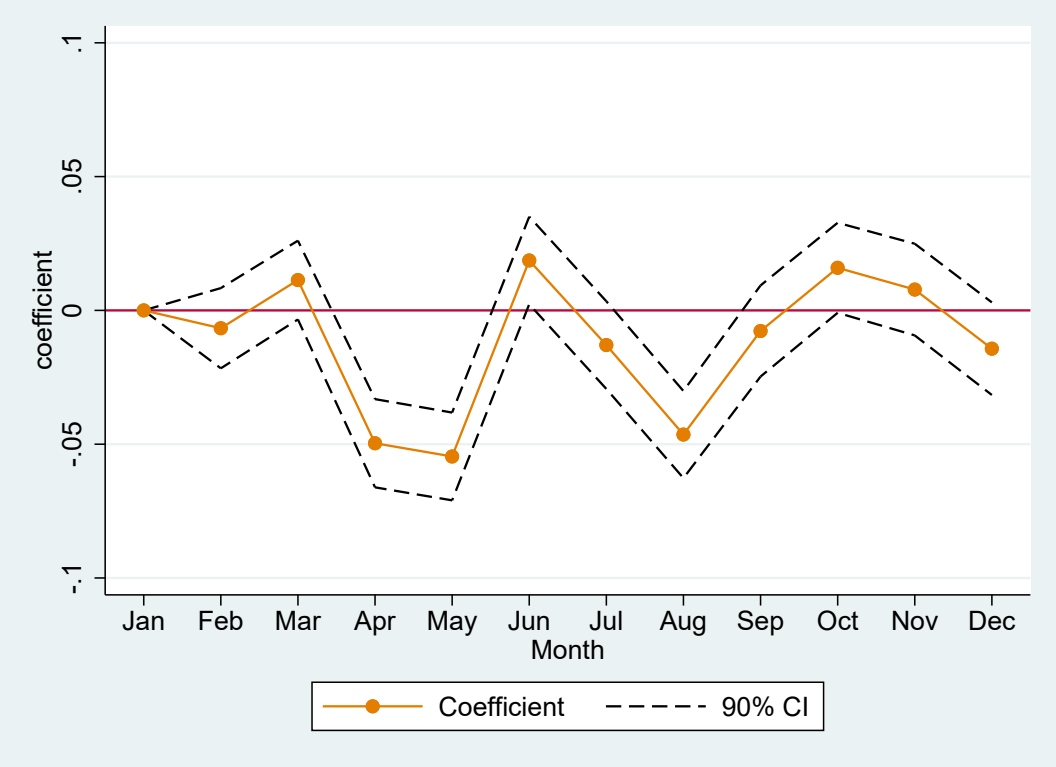


Figure 4: The figure reports the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Elderly}$ from estimating Equation (1) using all products. The dotted lines represent the 90% confidence interval bands.

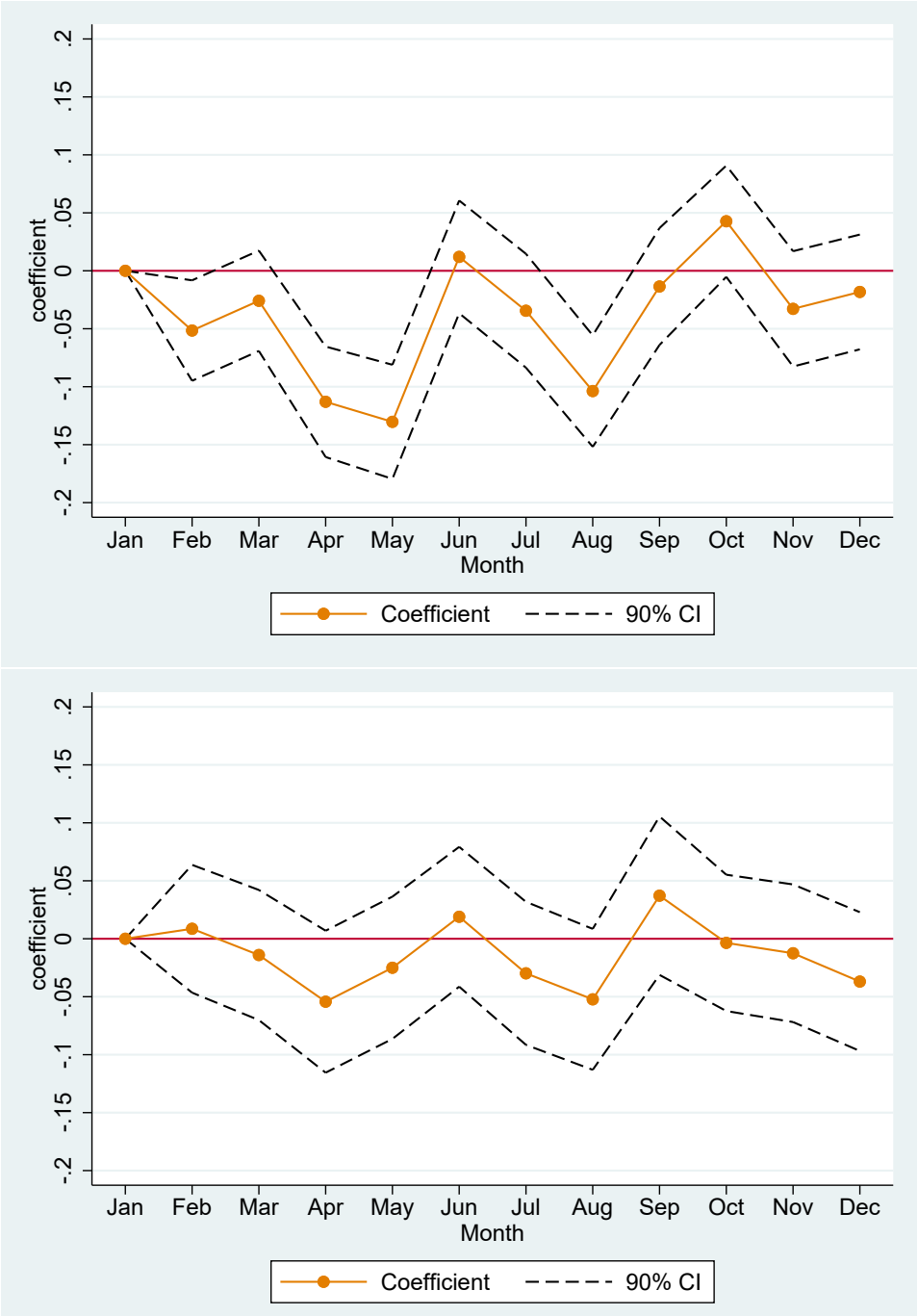


Figure 5: The top and bottom panels report the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Elderly}$ from estimating Equation (1) using the subsample of food and drink products and products other than food and drinks, respectively. The dotted lines represent the 90% confidence interval bands.

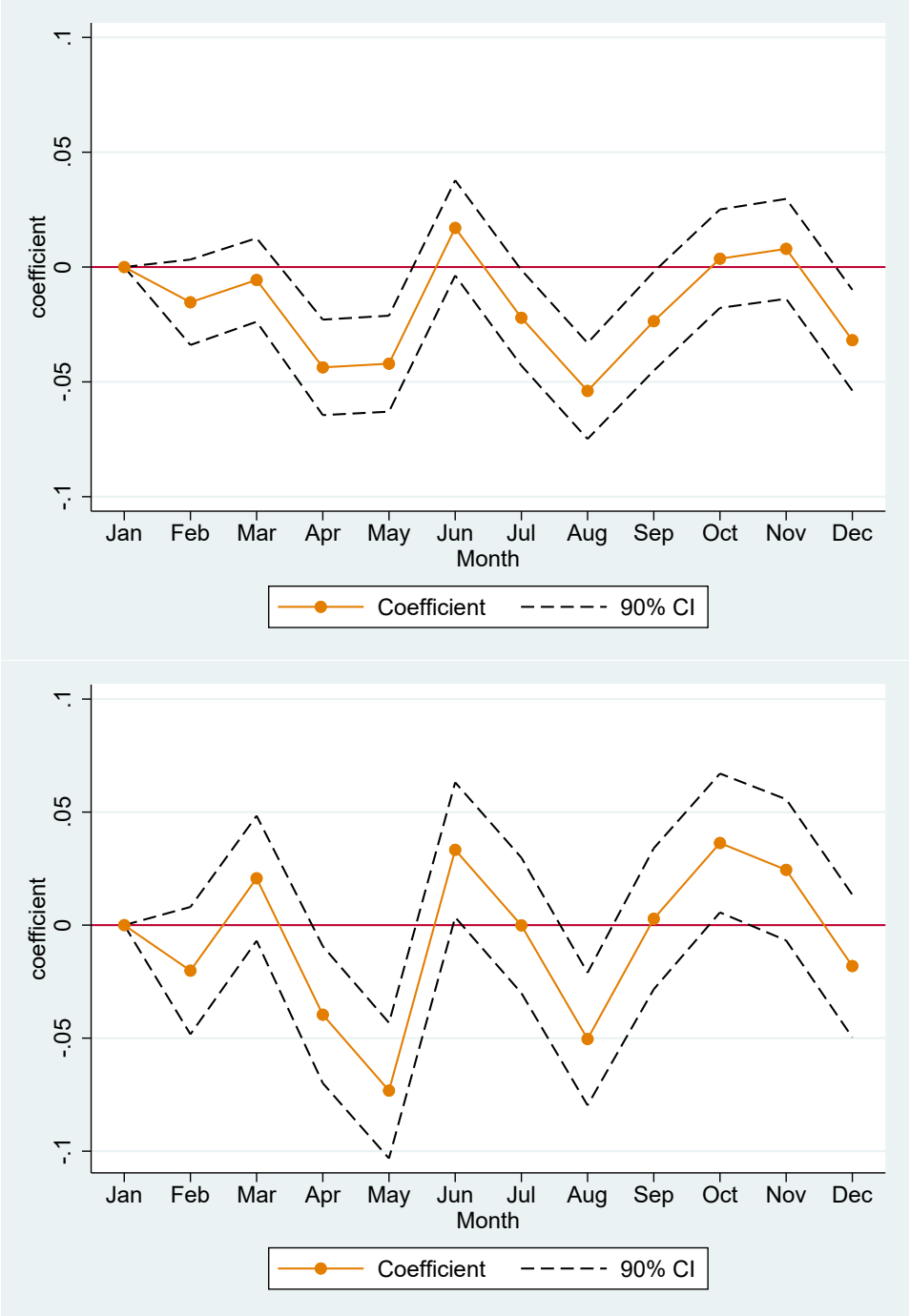


Figure 6: The top and bottom panels present the development of the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Cohort_6}$ and $D^{Cohort_7}$ for those in their 60s and 70s using all products, respectively. The dotted lines represent the 90% confidence interval bands.

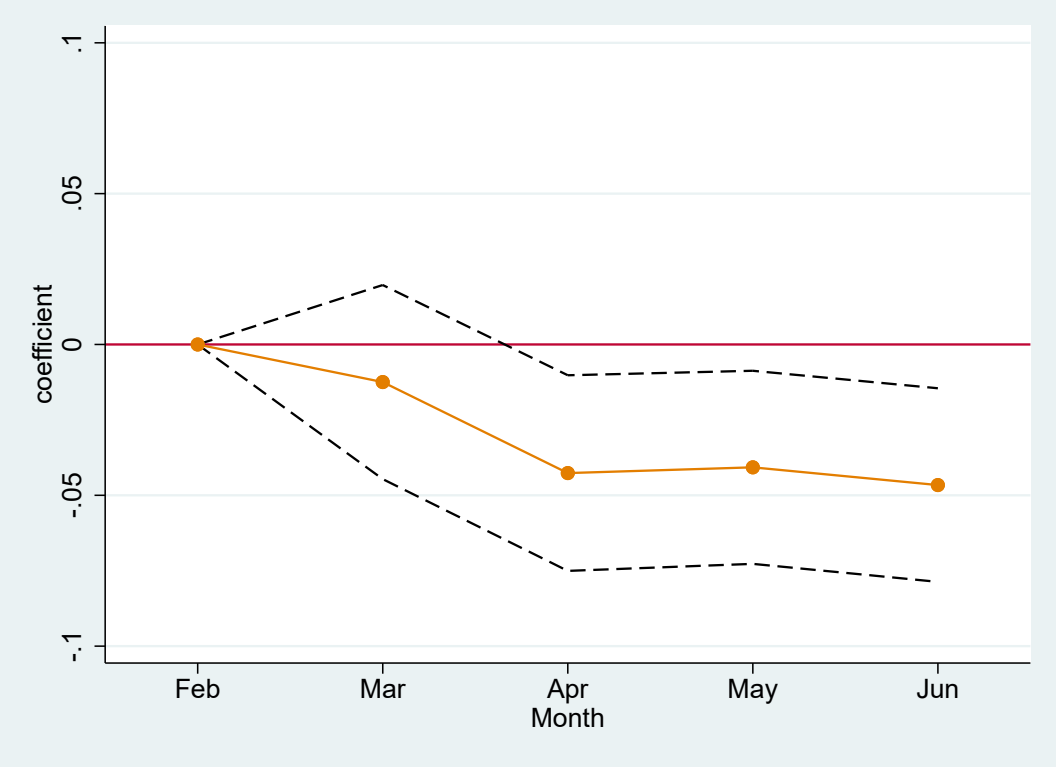


Figure 7: The figure reports the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Fear}$ from estimating Equation (2) using all products. The dotted lines represent the 90% confidence interval bands.

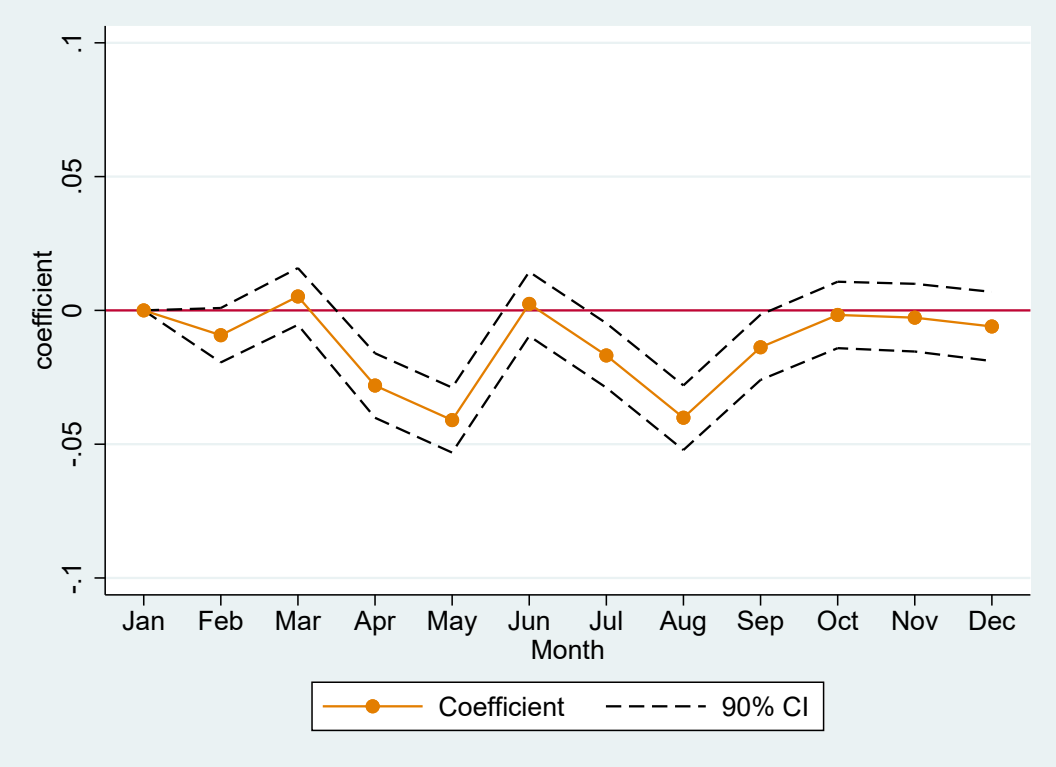


Figure 8: The figure reports the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Elderly}$ from estimating Equation (3) using all products. The dotted lines represent the 90% confidence interval bands.

# A Questionnaire: Survey on the effects of the COVID-19 pandemic on daily life

Intage Inc. surveys the effects of the COVID-19 pandemic on daily life from October 23, 2020 to November 4, 2020. The questions are as follows.

**Survey (I): How has the COVID-19 pandemic affected your daily life? Please indicate the situation for yourself for each period: (A) April–May, (B) June, (C) July–August, and (D) September–Present. If both suspension and resumption occurred during the same period, please select both.**

(1) School closed

(2) School reopened

(3) Culture lesson (including tutoring school) closed

(4) Culture lesson (including tutoring school) reopened

(5) Had to take a leave of absence from work (including from part-time job)

(6) Resumed work (including part-time job)

(7) Lost job (including part-time job)

(8) Got a new job (including part-time job)

(9) Income decreased

(10) Income increased

(11) Workload increased

(12) Workload decreased

(13) Worked from home more than 20 days per month

(14) Worked from home around half of the month

(15) Worked from home around one day per week

(16) Changed method of commuting to work (or school)

(17) Staggered commute to work (or school)

(18) Fewer opportunities to eat out

(19) Increased opportunities to eat out

(20) Fewer opportunities to cook at home

(21) Increased opportunities to cook at home

(22) Fewer leisure activities and trips

(23) Increased number of leisure activities and trips

(24) Fewer trips to nearby places such as window shopping

(25) Went out more for window shopping and other local activities

(26) Decreased frequency of wearing make-up or dressing up

(27) Increased frequency of make-up and dressing up

(28) Decreased frequency of skin care

(29) Increased frequency of skincare

(30) Increased time spent with family

(31) Decreased time spent with family

(32) Increased time spent watching TV

(33) Increased time spent on the Internet and similar activities.

(34) Have not been affected at all

(35) Do not want to answer

**Survey (II): How has the COVID-19 pandemic affected you daily life? Please indicate the situation for the family members who live with you for each period: (A) April–May, (B) June, (C) July–August, and (D) September–Present. If both suspension and resumption occurred during the same period, please select both.**

(1) School closed

(2) School reopened

(3) Culture lesson (including tutoring school) closed

(4) Culture lesson (including tutoring school) reopened

(5) Had to take a leave of absence from work (including from part-time job)

(6) Resumed work (including part-time job)

(7) Lost a job (including part-time job)

(8) Got a new job (including part-time job)

(9) Income decreased

(10) Income increased

(11) Workload increased

(12) Workload decreased

(13) Worked from home for more than 20 days per month

(14) Worked from home around half of the month

(15) Worked from home about one day per week

(16) Changed method of commuting to work (or school)

(17) Staggered commute to work (or school)

(18) Fewer opportunities to eat out

(19) Increased opportunities to eat out

(20) Fewer opportunities to cook at home

(21) Increased opportunities to cook at home

(22) Fewer leisure activities and trips

(23) Increased number of leisure activities and trips

(24) Fewer trips to nearby places such as window shopping

(25) Went out more for window shopping and other local activities

(26) Decreased frequency of wearing make-up or dressing up

(27) Increased frequency of make-up and dressing up

(28) Decreased frequency of skin care

(29) Increased frequency of skincare

(30) Decreased frequency (opportunity) of skin care for family members who live with you

(31) Increased frequency (opportunity) of skin care for family members who live with you

(32) Have not been affected at all

(33) No family members who live with you

(34) Do not want to answer

Based on the answers to Surveys (I) and (II) about school closure in Questions (1) and (2), employment status in Questions (7) and (8), income shocks in Questions (9) and (10), and the frequency of eating out in Questions (18) and (19), we construct 16 (eight by two) dummy variables. The dummy variables for the respondent and the family members correspond to school closure ($D_t^{SchoolClose}$ and $D_t^{SchoolReopne}$), employment status ($D_t^{Unemployment}$ and $D_t^{GettingJob}$), income shocks ($D_t^{IncomeUp}$ and $D_t^{IncomeDown}$), and the frequency of eating out ($D_t^{IncreaseEatout}$ and $D_t^{DecreaseEatout}$). The dummy variables take 1 when a respondent answers "YES" to each question in period $t$, and 0 otherwise. For example, assuming that a respondent answers "YES" to Question (1) regarding Period (D) in Survey (I), $D_t^{SchoolClose}$ takes 1 from September to November.

# B Additional tables and figures

Table B.1: Basic statistics of the survey on the effects of the COVID-19 pandemic on daily life. Source: Intage Inc.

| Respondent | Apr.–May 2020 | June 2020 | July–Aug. 2020 | Sept.–Nov. 2020 |
|---|---|---|---|---|
| Unemployment | 1.38% | 0.82% | 0.83% | 0.69% |
| Return to work | 1.00% | 0.65% | 0.92% | 1.11% |
| School close | 2.81% | 0.46% | 0.38% | 0.15% |
| School reopen | 0.58% | 1.83% | 0.50% | 0.72% |
| Eating out more | 1.06% | 5.10% | 5.83% | 18.82% |
| Eating out less | 59.35% | 40.29% | 35.45% | 20.49% |
| Increase in income | 1.29% | 1.86% | 2.04% | 2.71% |
| Decrease in income | 16.52% | 11.32% | 9.79% | 7.57% |
| Work from home ($\geq$ 20 days per month) | 5.34% | 2.95% | 2.56% | 2.15% |
| Work from home ($\geq$ 10 days per month) | 5.21% | 3.16% | 2.52% | 2.23% |
| Work from home (once a week) | 4.38% | 2.87% | 2.61% | 2.25% |
| Observations | 32,911 | 33,358 | 34,028 | 46,743 |
| Family members who live with the respondent | Apr.–May 2020 | June 2020 | July–Aug. 2020 | Sept.–Nov. 2020 |
| Unemployment | 0.84% | 0.43% | 0.45% | 0.39% |
| Return to work | 0.34% | 0.29% | 0.34% | 0.49% |
| School close | 20.93% | 3.37% | 2.33% | 5.88% |
| School reopen | 2.72% | 14.23% | 3.00% | 2.90% |
| Eating out more | 0.85% | 2.70% | 4.44% | 12.16% |
| Eating out less | 36.16% | 25.64% | 22.15% | 14.23% |
| Increase in income | 0.57% | 0.81% | 0.88% | 1.34% |
| Decrease in income | 11.08% | 7.78% | 6.42% | 4.70% |
| Work from home ($\geq$ 20 days per month) | 5.73% | 3.15% | 2.69% | 2.13% |
| Work from home ($\geq$ 10 days per month) | 5.14% | 3.15% | 2.51% | 1.85% |
| Work from home (once a week) | 4.09% | 3.16% | 2.39% | 2.00% |
| Observations | 32,911 | 33,358 | 34,028 | 46,743 |

Table B.2: Estimation results from a dynamic difference-in-differences approach

| | | All products | Food and drink | Other than food and drink |
|---|---|---|---|---|
| $\gamma_1$: | January (Base month) | 0.000 | 0.000 | 0.000 |
| | | (0.000) | (0.000) | (0.000) |
| $\gamma_2$: | February | −0.007 | −0.052* | 0.009 |
| | | (0.009) | (0.026) | (0.034) |
| $\gamma_3$: | March | 0.011 | −0.026 | −0.014 |
| | | (0.009) | (0.026) | (0.034) |
| $\gamma_4$: | April | −0.050*** | −0.113*** | −0.054 |
| | | (0.010) | (0.029) | (0.037) |
| $\gamma_5$: | May | −0.055*** | −0.130*** | −0.025 |
| | | (0.010) | (0.030) | (0.037) |
| $\gamma_6$: | June | 0.019* | 0.0120 | 0.019 |
| | | (0.010) | (0.030) | (0.037) |
| $\gamma_7$: | July | −0.013 | −0.035 | −0.030 |
| | | (0.010) | (0.030) | (0.038) |
| $\gamma_8$: | August | −0.046*** | −0.104*** | −0.052 |
| | | (0.010) | (0.029) | (0.037) |
| $\gamma_9$: | September | −0.008 | −0.014 | 0.037 |
| | | (0.010) | (0.031) | (0.042) |
| $\gamma_7$: | October | 0.016 | 0.043 | −0.004 |
| | | (0.010) | (0.029) | (0.036) |
| $\gamma_8$: | November | 0.008 | −0.033 | −0.013 |
| | | (0.010) | (0.030) | (0.036) |
| $\gamma_9$: | December | −0.014 | −0.018 | −0.037 |
| | | (0.011) | (0.030) | (0.036) |
| Observations | | 338,926 | 226,656 | 166,897 |

Notes: The table reports the $\gamma$ coefficients on the cross-term between month dummies and $D^{Elderly}$ The standard errors between parentheses are clustered at the individual level. *, **, and *** indicate significance at the $10\%$, $5\%$, and $1\%$ levels, respectively.

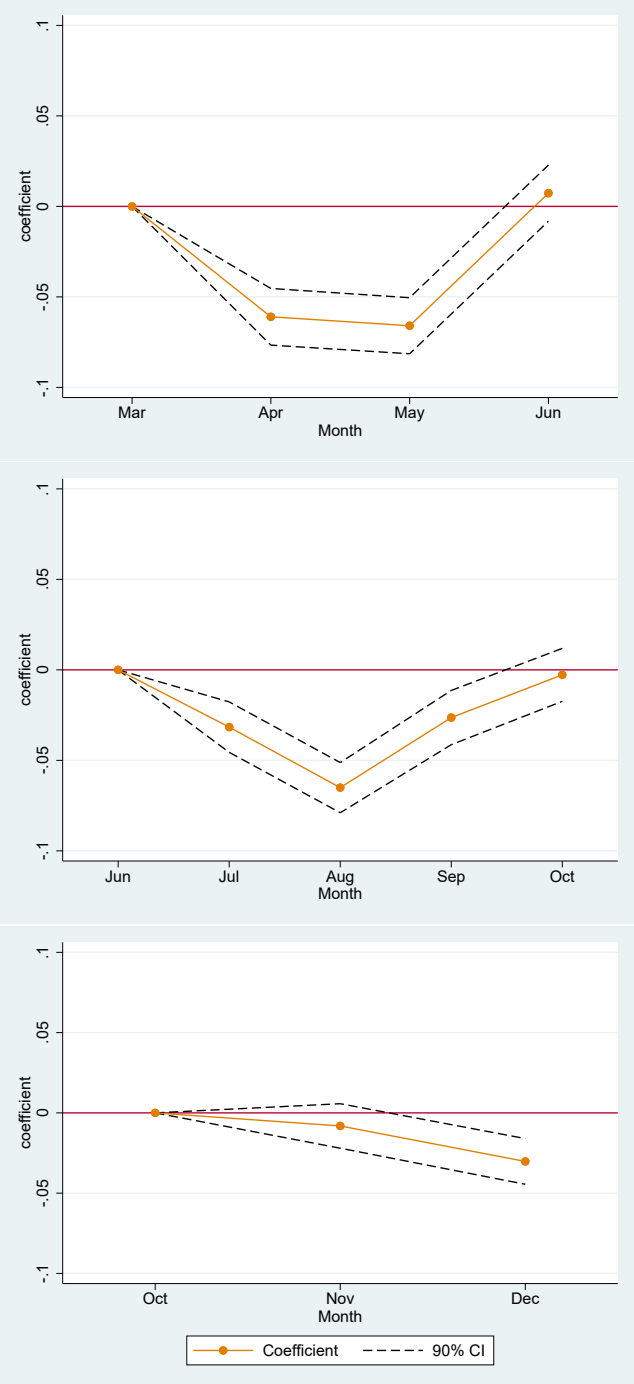


Figure B.1: The figure reports the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Elderly}$ from estimating Equation (1) using all products. The top, middle, and bottom panels present the development of the $\gamma$ coefficients with March, June, and October as the base months, respectively. The dotted lines represent the 90% confidence interval bands.

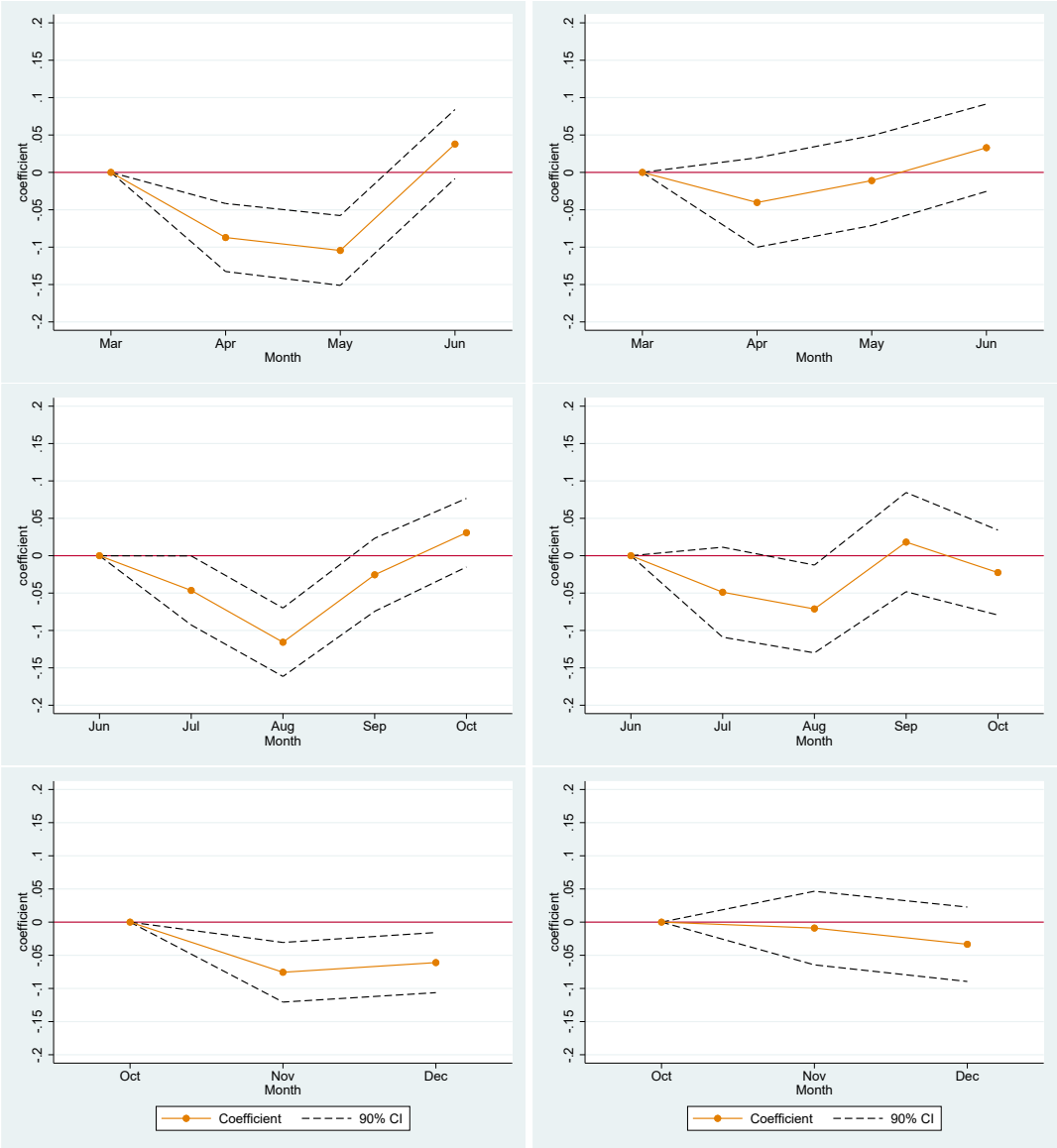


Figure B.2: The left- and right-hand side panels represent the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Elderly}$ from estimating Equation (1) using the subsample of food and drink products and products other than food and drink, respectively. The top, middle, and bottom panels present the development of the $\gamma$ coefficients with March, June, and October as the base months, respectively. The dotted lines represent the 90% confidence interval bands.

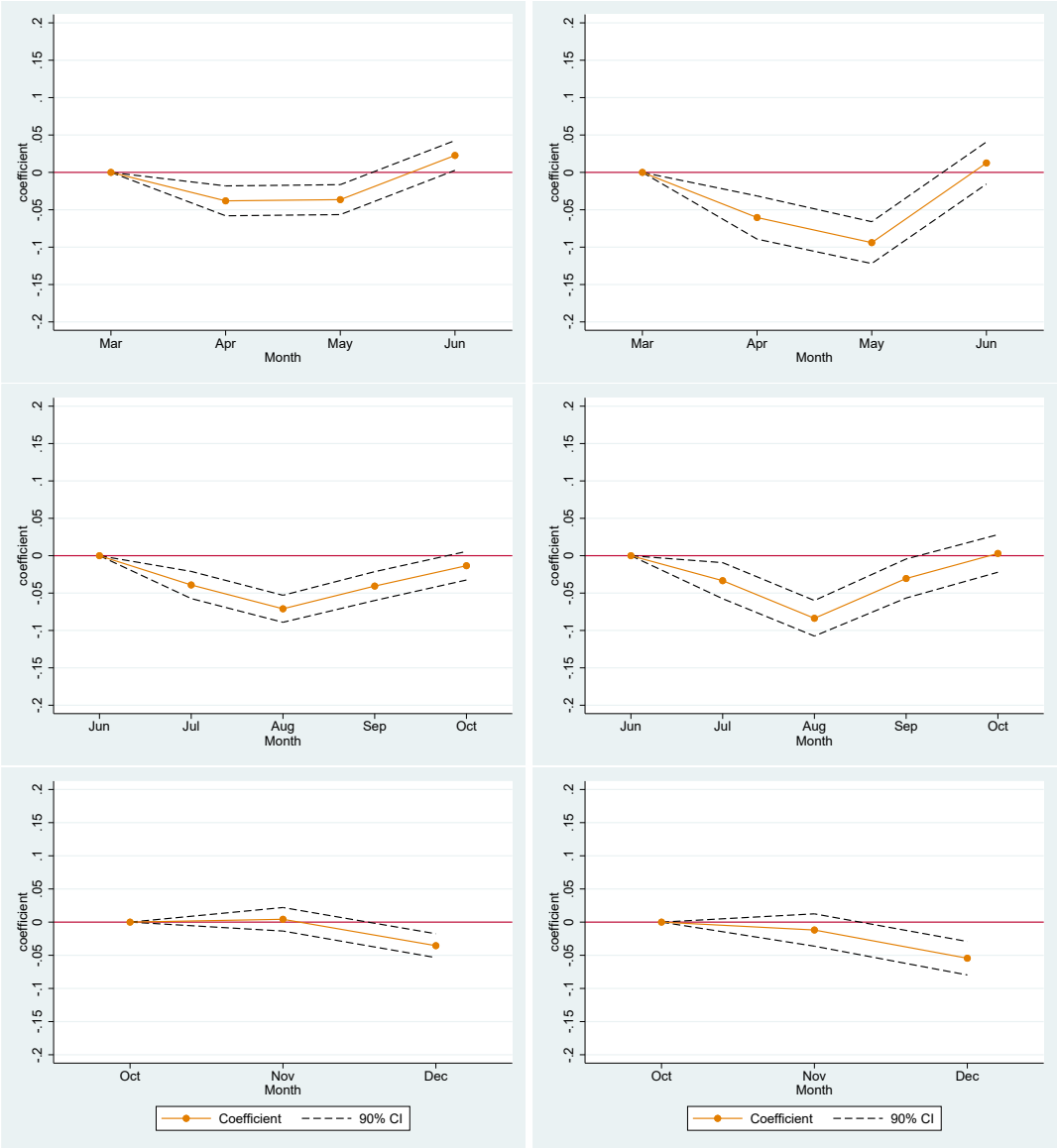


Figure B.3: The left- and right-hand side panels present the development of the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Cohort_6}$ and $D^{Cohort_7}$ for those in their 60s and 70s using all products, respectively. The top, middle, and bottom panels present the development of the $\gamma$ coefficients with March, June, and October as the base months, respectively. The dotted lines represent the 90% confidence interval bands.

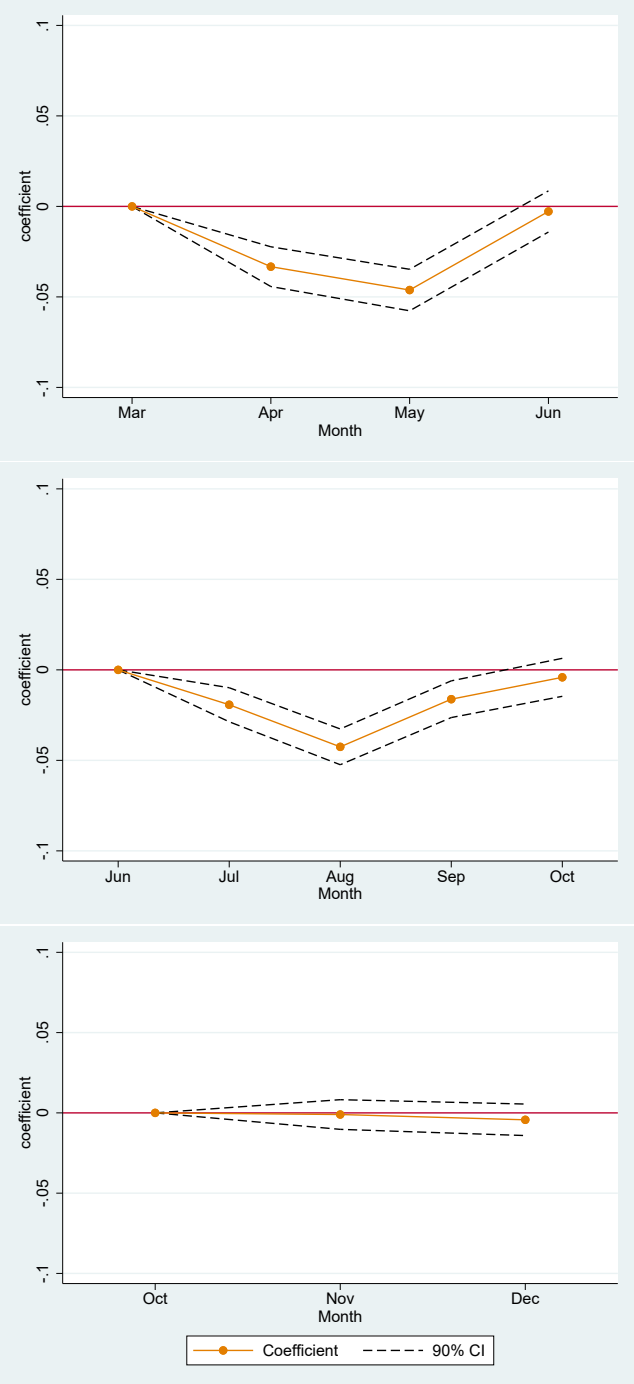


Figure B.4: The figure reports the $\gamma$ coefficients on the interaction terms between the month dummies and $D^{Elderly}$ from estimating Equation (3). The top, middle, and bottom panels present the development of the $\gamma$ coefficients with March, June, and October as the base months, respectively. The dotted lines represent the 90% confidence interval bands.