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Who faces higher prices?

–An empirical analysis based on Japanese homescan data–

Naohito Abe
and
Kyosuke Shiotani

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Research Center for Price Dynamics
Institute of Economic Research, Hitotsubashi University
Naka 2-1, Kunitachi-city, Tokyo 186-8603, JAPAN
Tel/Fax: +81-42-580-9138
E-mail: rcpd-sec@ier.hit-u.ac.jp
http://www.ier.hit-u.ac.jp/~ifd/

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Naohito Abe[2] (Hitotsubashi Univeristy) and
Kyosuke Shiotani (Bank of Japan[3])

Very Preliminary.

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Abstract

On the basis of household-level scanner data (homescan) for Japan over a three-year period, we construct a household-level price index, and we investigate the causes of the differences in prices across households. As noted by Aguiar and Hurst (2007), large price differentials across households are observed. The differences across age and income groups, however, are small. In addition, we find that elderly people face higher prices than younger people, which is opposite of the results of Aguiar and Hurst (2007). The most important determinant of the price level is the reliance on bargain sales; an increase in the purchase at bargain sales by one standard deviation decreases the price level by more than 0.9%, while the shopping frequency has only limited effects on the price level.

1. Introduction

Because of recent technological developments in data creation, numerous researchers of commodity prices have begun to use not only traditional aggregates, such

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[2] Naohito Abe: The Institute of Economic Research, Hitotsubashi University. Naka, Kunitachi Tokyo. E-mail: nabe@ier.hit-u.ac.jp. Phone: +81-425-80-8347. b

[3] The views expressed in this paper are those of the authors and are not reflective of those of the Bank of Japan.

as the consumer price index, but also information on micro-level commodity prices. To date, micro-level price information has been used in various economic fields, such as macroeconomics (Nakamura and Steinsson (2007)), international economics (Haskel and Wolf (2001)) and industrial economics (Bay et al. (2004)). Recently, on the basis of commodity-level scanner data, Aguiar and Hurst (2007) found that a violation of the law of one price can be found across different age groups. More precisely, elderly families face lower prices for the same commodities than younger families in the United States. Aguiar and Hust (2007) interpret their results in line with the standard life cycle model of consumption with endogenous decisions of shopping time. The mechanism is simple. Because the opportunity costs of shopping for retired people are lower than those for young people, elderly people tend to shop more to find lower prices, which results in the violation of the law of one price.

On the basis of commodity price information compiled from registers at supermarkets, Broda and Romalis (2010) argue that the standard consumer price index for poor families in the US has a significant upper bias, which underestimates the real income of poor families. This bias also comes from the violation of the law of one price, that is, poor families face lower prices for the same commodities than rich families.

This paper considers the relationship between shopping behaviors and price level based on scanner data for Japan.[4] Similar to Aguiar and Hurst (2007), we find a significant violation of the law of one price in the data for Japan. Figure 1 illustrates the distribution of the relative commodity price index following Aguiar and Hurst (2007).[5] The index takes a value of unity if the recorded price is equal to the regional average price. A value of 1.2 implies that the price is 20% larger than the average. The figure clearly shows that the same products are sold at very different prices. We also find, however, that the differences or price levels across age or income groups are very small.

Other than income and age, we find several important determinants of the price index. The most important determinant of the price level is the ratio of purchases at bargain sales. By increasing the purchase at bargain sales by one standard deviation, people can enjoy a reduction in their price level of 0.9%, which is consistent with Griffith et al. (2009), who find a significant amount of savings from purchasing at

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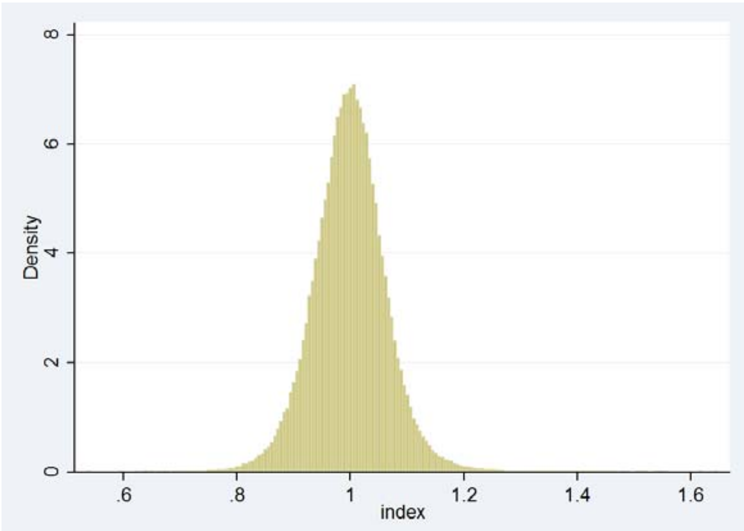
[4] Even if the law of one price holds, as long as there are heterogeneity in composition in household expenditures, the rates of inflation can be different across households. Japanese statistical bureau reports the inflation rate across different age and income groups. There are also several papers that investigate the differences in inflation rate based on the difference in compositions. See Kitamura (2008), Kuroda and Yamamoto (2010) , and Unayama and Keida (2011), for example. All of them, however, did not use product level information of prices as in Aguiar and Hurst (2007).

[5] The figure shows the distribution of the household level monthly price index. The definition of the index will be given in the next section.

bargain sales in the United Kingdom. Although other shopping behaviors, such as frequency of shopping, the degree of mass purchasing, or preference for high quality goods, are all statistically significant, these behaviors are not quantitatively important. Our empirical results suggest that further investigation into shopping strategy, particularly determinants of purchasing at bargain sales, is necessary to understand the mechanism behind the price level differential across families.

Figure 1: Distribution of the relative price index across households



Note: The definition of the price index is given in Section 3.

2. Data

The data set in this paper are from the “Household Consumer Panel Research” (SCI hereafter) data set compiled by Intage, a marketing company in Japan. SCI began in 1964 as a diary survey. A randomly selected set of 12,000 households from all over Japan installed a barcode reader in their houses and scanned the barcodes of commodities they purchased daily. The data scanned by the barcode readers are transferred automatically to the data center of Intage through a high-speed network. SCI is virtually the only available homescan data source that covers all of Japan.

SCI records (1) the commodity code (JAN code) that is supposedly a unique commodity identifier,[6] (2) the day of shopping, (3) the price and quantity of each

[6] JAN (Japanese Article Number) code is managed by The Distribution Systems Research Institute. The code is compatible with the Universal Product Code (UPC). Although the JAN code is supposedly a unique identifier, some companies use the same JAN code for different products. Intage creates its own additional code to deal with the repeated use of JAN code. We use both JAN and Intage codes to

commodity, and (4) the name of the store. In addition, the sampled households record their basic information, such as age of husband and wife, income, and educational background, once a year. The sample households are restricted to married couples where the wife is younger than 70 years. The same households are tracked for a maximum of 10 years, which provides daily household- and commodity-level panel data.

Although the information contained in SCI is much richer than standard diary-based surveys on household expenditure, such as the Consumer Expenditure Survey, it has several limitations. Because SCI is recorded through barcode readers, commodities without a barcode, such as fresh vegetables, meat, fish, and fruits, are not included.[7] Furthermore, no information is available about expenditures from dining out, for durable goods, and for services. These limitations are shared by the homescan data of AC Nielsen in the US.

The data we use in this paper cover three years, from 2004 to 2006. Table 1 shows the distribution of the family composition. KHPS (Keio Household Panel Survey) is used widely among economic researchers in Japan as one of the standard panel surveys. Compared with the Census, the sample households of SCI contain more family members. A similar bias can be found in KHPS. Table 2 shows the age distribution of the sample wife, while Table 3 reports the employment status of the wife. We can observe that a significant number of wives are not in paid employment.

3. Relative Price Index

Homescan data such as that available from Intage or AC Nielsen enable us to observe detailed purchasing behaviors by each household, including actual purchasing prices and quantities. Therefore, it is tempting to construct a standard Laspeyres or Paasche price index to compare price levels among families. This task is not easy, unfortunately. While there are hundreds of thousands of different products in the dataset, each household purchases fewer than one hundred items each month. Therefore, if we try to construct a Laspeyres or Paasche index, we will encounter many zeros, which cause serious downward (Paachse) or upward (Laspeyres) biases. To avoid this complexity, following Aguiar and Hurst (2007), we construct the price index as follows.

Let us consider a commodity that belongs to a product category $c \in C$. Denote

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identify commodities.

[7] Compared to the standard diary base consumption data such as Family Income and Expenditure Survey, homescan data cover about 20 % of expenditure on goods.

the price of good $i \in I_c$ purchased by household $j \in J$ on date $t \in T$ by $p_{i,t}^{j,c}$, and the quantity by $y_{i,t}^{j,c}$. Then, the total expenditure by the household during time interval *m* can be written as,

$$X_m^j = \sum_{c \in C, i \in I_c, t \in m} p_{i,t}^{j,c} y_{i,t}^{j,c} .$$

If the household purchases each product at the average price, the expenditure would be:

$$\overline{X}_m^j = \sum_{c \in C, i \in I_c, t \in m} \overline{p}^c{}_{i,m} y_{i,t}^{j,c} ,$$

where

$$\overline{p}^c{}_{i,m} = \sum_{j \in J, t \in m} p_{i,t}^{j,c} \frac{y_{i,t}^{j,c}}{\sum_{j \in J, t \in m} y_{i,t}^{j,c}},$$

is the weighted average price paid for a good *i* in category c during time interval *m*. Now, we define the price index for the household as the ratio of actual expenditure divided by the expenditure at the average price $\overline{p}^c{}_{i,m}$ as follows:

$$\tilde{p}_m^j \equiv \frac{X_m^j}{\overline{X}_m^j} .$$

Finally, we normalize the index by dividing by the average price index within the month to obtain:

$$p_m^j \equiv \frac{\tilde{p}_m^j}{\frac{1}{J} \sum_j \tilde{p}_m^j} .$$

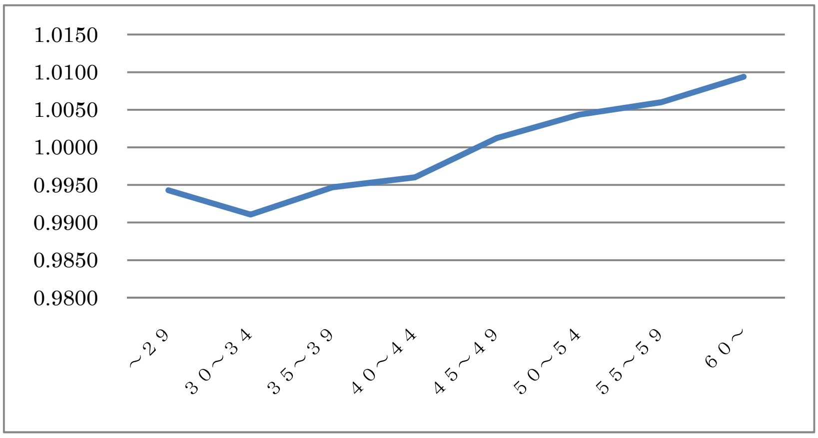
This household-level price index shows the relative price each household faces to the average price.[8] Figure 2 shows the life-cycle profile of this price index. The horizontal axis shows the age of the wife, while the vertical axis indicates the price index. As is clear from the figure, the price index increases with age; it does not decrease, as stated by Aguiar and Hurst (2007). Moreover, the slope is very small, which implies that the differences in prices across age groups are extremely limited; the absolute value of the slope is approximately one-third that estimated in the US. Figure 3 also shows the relationship between the price index and household income. Similar to Figure 2, we can observe a slightly upward line of price over income, which implies households with greater income face moderately higher prices than poor families.

[8] When calculating the average price for each commodity, we use the regional average that divides entire Japan into 10 different regions.

Table 4 shows the regression coefficients for income and age dummies when the dependent variable is the natural logarithms of the price index. The effects of age and income group dummies on the price index are quite stable and are highly significant. However, the values of the coefficients are generally not so large. According to specification (1) in Table 5, rich households whose income is over 9 million yen face 0.013-point higher prices than the poorest income group.

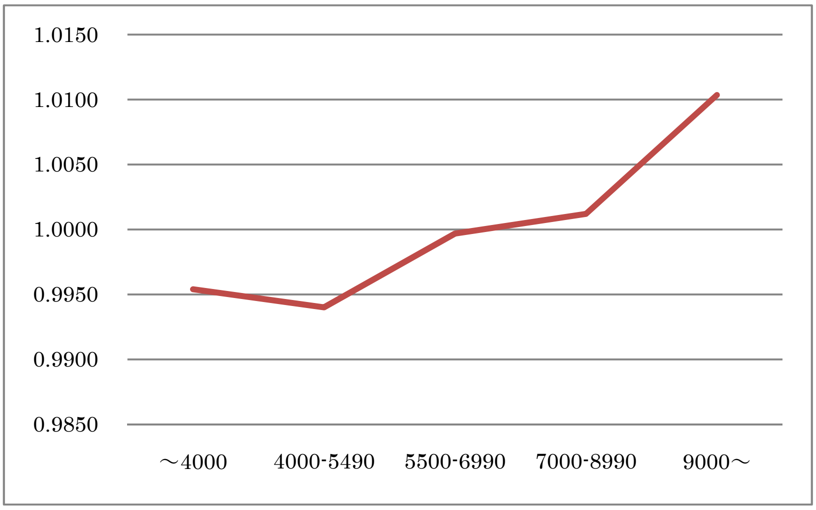
It is worth noting that this price index cannot capture the movements of prices over time because the average of the price index is always unity.

Figure 2: Life-Cycle Profile of Price Index



Note: The horizontal axis is the age of wife.

Figure 3: Household Income and Price Index



Note: The horizontal axis is household income whose unit is 1,000 yen.

4. Shopping Behaviors

One of the main results of Aguiar and Hurst (2007) is that elderly people can lower their prices by increasing their shopping frequency. In this section, in addition to the shopping frequency, we introduce other shopping behaviors that might affect the relative price index introduced in the previous section.

Shopping frequency: (ln trip)

First, for the measure of the shopping frequency, we use the number of stores households use. More precisely, we first count the number of different stores a sample household visits each day. Next, we calculate the sum of the number for each month, which gives the index for the degree of shopping frequency. The greater the shopping frequency, the higher the likelihood for encountering lower prices, which leads to a lower price index.

The number of different stores: (ln stores)

We also use the total number of stores a household visits in a month.

Our measure for the shopping frequency is the gross monthly total number of stores a household uses. This measure captures the variety of shops each household uses. Note that this measure does not include information regarding frequent shopping at the same store. This variable can be used as a proxy for search intensity, which might lead to a lower price index, to find the people who use some stores in search of better prices.

HHI : (ln HHI)

Next, we construct the Herfindahl-Hirschman Index (HHI) to capture the concentration of spending. HHI is a measure of the amount of competition in the industry. We use it as an indicator for the degree of concentration of stores where the households purchase goods. For example, consider two households. Both families go to three stores in a month. One of the families relies on a large supermarket and spends 90 % of the monthly expenditure at the supermarket, while the other family spends evenly across the three stores. Our HHI index captures the difference in such shopping behaviors.

HHI is defined as follows:

$$HHI_m^j \equiv \sum_{k=1}^{K} {S_{k,m}^j}^2,$$

where $S_{k,m}^j$ is the share of store $k \in \mathrm{K}$ in monthly total purchases of household j.

The total number of goods bought by a household: (ln quantity)

We consider the monthly total number of goods a household buys.

$$Quantity_m^j = \sum_{c\in C, i\in I_c, t\in m} y_{i,t}^{j,c}$$

It is reasonable to suppose that a family buying many goods can enjoy volume discounts more, thus decreasing the price level.

Non-bargain Index : (non_bargain)

To observe the effect of buying at bargain sales, we construct a measure for bargains. As might be expected, a household can decrease their price index by purchasing more goods at bargain sales.

Because of the lack of store-level flags for bargain sales in our dataset, it is necessary to define the price at bargain sales based on information regarding the movements of store-level prices. In this paper, we adopt the store-level monthly minimum price for each good, $min\, P_{i,t}^c$, as the price at bargain sales. Then, the following index is used,

$$non\ bargain_m^j = \frac{\sum_{c\in C, i\in I_c, t\in m} I\left(P_{i,t}^{j,c}\right) p_{i,t}^{j,c} y_{i,t}^{j,c}}{\sum_{c\in C, i\in I_c, t\in m} p_{i,t}^{j,c} y_{i,t}^{j,c}},$$

where

$$I\left(P_{i,t}^{j,c}\right) = \begin{cases} 1, & P_{i,t}^{j,c} > min\ \ P_{i,t}^c \\ 0, & Otherwise \end{cases},$$

shows the ratio of expenditure at prices higher than the bargain sales. A household with a large non-bargain index is purchasing products at higher prices than bargain sales, which lowers the relative price index. It is worth noting that this measure captures the importance of temporal reduction within a month. If prices are stable for several months, or if bargain sales last more than one month, this index fails to capture the importance of bargain sales.

Store Choice index: (ln store_choice)

Generally, most products can be purchased at both luxury stores and discount stores. The movement of prices differs across stores to a great extent. Abe and Tonogi (2009) show that prices move very differently across stores based on a large point-of-sale database of Japanese stores. Suppose a rich family has greater opportunity costs for shopping than poor families. Also, suppose that a rich family tends to use luxury stores. Then, it is probable that luxury stores sell commodities at higher prices than standard supermarkets because customers can reduce their shopping costs by buying goods at one shop even if they know other stores have set lower prices for exactly the same goods. However, discount shops cannot set higher prices for common goods because common goods are the main products of discount shops, which expect that customers will change their favorite shops if they increase the prices of commonly used goods. Thus, it is worth examining the effects of the quality of stores on the price index.

We define the index for the quality of each store, $k \in \mathrm{K}$, by basically following the relative price index. The store quality index is the ratio of the hypothetical sales if the store sells the goods at their average price $\bar{P}_{i,m}^{c}$ to the sales if the store sells the goods at their categorical average goods. More precisely, first, we obtain the average price for a given good in category $c \in C$ as:

$$\bar{P}_m^c = \sum_{i \in I_c, k \in K, t \in m} p_{i,t}^{k,c} \frac{y_{i,t}^{k,c}}{\sum_{i \in I_c, k \in K, t \in m} y_{i,t}^{k,c}}$$

Next, assuming that the stores sell the average goods in each category at the average price, we obtain the total sale as:

$$\bar{Z}_m^k = \sum_{c \in C, i \in I_c, t \in m} \bar{p}_m^c y_{i,t}^{k,c}.$$

Then, we calculate the total sales of store k if it sells the goods at their average prices

$$\bar{p}_{i,m}^{c} = \sum_{k \in K, t \in m} p_{i,t}^{k,c} \frac{y_{i,t}^{k,c}}{\sum_{k \in K, t \in m} y_{i,t}^{k,c}},$$

$$Z_m^k = \sum_{c \in C, i \in I_c, t \in m} \bar{p}_{i,m}^{c} y_{i,t}^{k,c}.$$

Now, the index for the quality of goods sold at store k is defined as:

$$\tilde{q}_m^k \equiv \frac{Z_m^k}{\bar{Z}_m^k}.$$

Finally, we normalize the index by dividing by the average monthly quality index as follows:

$$q_m^{\mathrm{k}} \equiv \frac{\tilde{q}_m^k}{\sum_{k \in K} \tilde{q}_m^k} ,$$

which gives us the quality index of a store k during the time interval m.

Note that this index does not imply that each store sets lower (or higher) prices for each good, as we use the average price to calculate the monthly total sales.

Second, using this store quality index, we construct a store choice measure for each household. We employ the average of the store quality index weighted by the share of each store in monthly total purchases of a household j.

$$Store\ choice_m^j \equiv \sum_{k \in K} S_{k,m}^j q_m^k$$

The greater the store choice index, the higher the likelihood of using luxury stores, which leads to a higher price index.

Quality Index: (ln quality)

Similar to the quality of stores, it is possible to create an index for the quality of goods bought by each household. The justification is the same as the store choice index. It seems reasonable to assume that a household buying luxury goods will go to luxury stores more often, leading to a higher price index.

The quality index for households is defined as the ratio of the hypothetical expenditure if the household purchases the goods at their average price $\bar{P}_{i,m}^c$ to the expenditure if the household purchases the goods at their categorical average goods $\bar{P}_m^c$. Assuming that the household buys the average goods in each category at the average price, the total expenditure is:

$$\bar{Z}_m^j = \sum_{c \in C, i \in I_c, t \in m} \bar{p}_m^c y_{i,t}^{j,c},$$

and the expenditure if the household purchases the goods at their average price is:

$$Z_m^j = \sum_{c \in C, i \in I_c, t \in m} \bar{p}_{i,m}^c y_{i,t}^{j,c},$$

The index for quality of goods bought by household *j* is defined as:

$$\tilde{q}_m^j \equiv \frac{Z_m^j}{\bar{Z}_m^j}.$$

and we normalize the index by dividing by the average monthly quality index as follows:

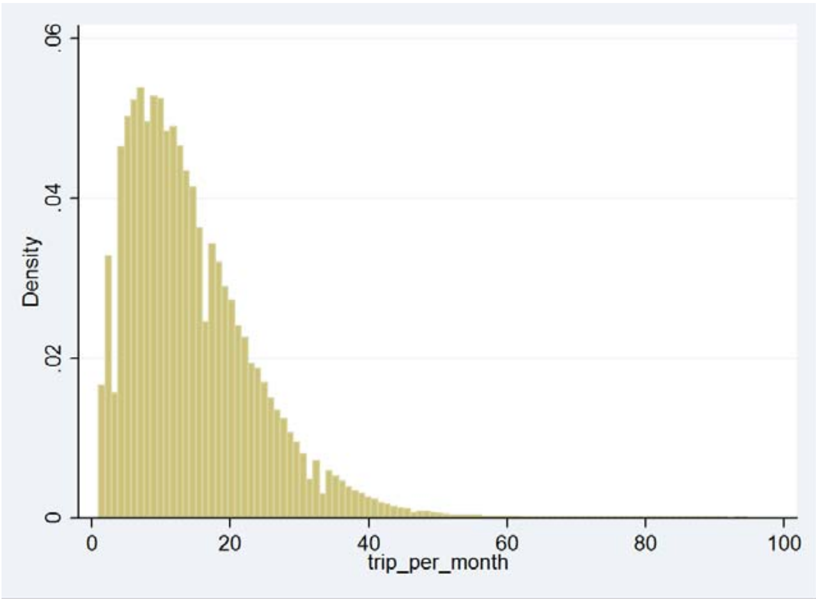
$$q_m^j \equiv \frac{\tilde{q}_m^j}{\sum_{j \in J} \tilde{q}_m^j}.$$

It is expected that the greater this quality index, the higher the price index.

As noted previously, this measure is not affected by other shopping strategies of each household, such as buying at sales, because it uses the average price of each good. In this index, we assume all households encounter the same prices for specific goods, so the greater index does not imply a household buys goods at higher prices than another household.

Table 6 reports the differences of these shopping behavior variables and the relative price index across different age and income groups. On average, Japanese families shop 14.4 times a month. The standard deviation of the number of trips is large, i.e., 9.5, which implies families are highly heterogeneous in their shopping frequency. Figure 4 confirms the heterogeneity. Some families shop more than 100 times a month. It is important to remember that this index counts multiple trips to the same store within the same day as only one trip.

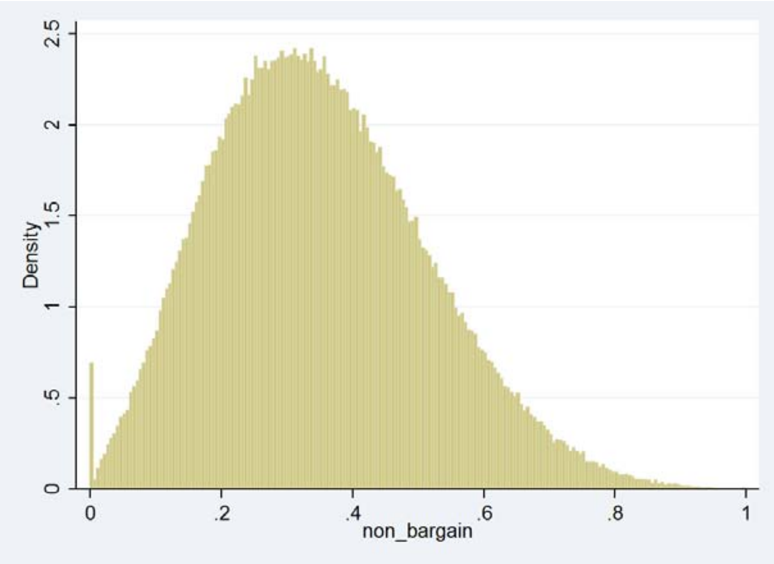
Figure 4: Distribution of the Frequency of Shopping per Month



The shopping frequency is at its maximum if the wife is 50-54 years old. We can also observe that the shopping frequency increases with income.

Not surprisingly, the ratio of non-bargain purchases increases with age and income. The standard deviation is also large. Figure 5 shows the distribution of the non-bargain ratio. We can observe a mass point at zero, which implies that a significant number of families purchase goods at the monthly minimum price only. There are also some families whose index is close to unity, implying that some families always purchase goods at higher prices rather than the monthly minimum price.

Figure 5: Distribution of the Non-Bargain Ratio



The shopping concentration measure, HHI, decreases with age and income, implying that elderly and rich families tend to disperse their expenditures across different stores.

5. The Relationships Between the Relative Price Index and Shopping Behaviors

Table 6 reports the estimated ordinary least squares results. Because of the endogeneity in the shopping behaviors, we should be careful to interpret the coefficients of the shopping behaviors, such as the frequency of trips. Because of the large sample size, some of the t-values exceed fifty. Except for the Hafindahl Index (lnHHI) and the number of different stores (lnstore), the sign of the shopping behaviors are generally consistent with the casual hypotheses raised in the previous section. For example, the coefficient of the frequency of trips (lntrip) is negative, which implies that households that purchase often face lower prices. Moreover, the size of the coefficient, -0.0137 in Spec (1), is similar to the results of the OLS in Aguiar and Hursts (2007).

The effects of income dummies are exceptionally stable. Controlling for shopping behaviors does not change the coefficients and their statistical significance, which implies that a positive relationship between the relative price index and income level reflects other mechanisms that are not captured from those considered in Section 4. The effects of age dummies, however, become smaller when the non-bargain ratio or the quality of goods is controlled. If both non-bargain ratio and quality of goods are controlled without other shopping behavior variables, the coefficient for the dummy for 60 or older becomes 0.0026, which is only 33% of the coefficient, 0.0078 at Spec (1) in Table 4. Therefore, the relationship between age and relative prices is related to the shopping behavior considered in Section 4. However, because of the endogeneity in our shopping variables, we need instrumental variables to consider the relationship further.

Aguiar and Hurst (2007) used dummies for income or age as instrumental variables. Unfortunately, the two-stage least square estimates with these instrumental variables cannot path the over-identification tests, or these instrumental variables are weak and the estimation results are unstable. Rather than relying on instrumental variables, we adopt a fixed effects model, which enables us to omit biases due to unobservable family level effects.

Table 7 shows the estimation results. Robust and stable relationships between shopping behaviors and the relative price index can be found in lnquantity, non-bargain ratio, lnstore_choice, and lnquality. The effects of age and income become much smaller than those reported in Table 6. The reason is simple: the fixed effects model uses information on the inner variation of each dependent variable. Because our dummies for income and age are categorical variables, there are few families whose categories changed during the sample periods. In other words, our categorical variables contain significant measurement errors to capture age or income effects, which leads to significant downward biases in the coefficients.

Table 8 reports the effects of an increase in each dependent variable by its one standard deviation on the relative price index. The effects of the non-bargain ratio have the greatest impact on the prices. The second greatest effects on the relative price index come from mass purchasing (lnquantity). With an increase in purchase quantity of one standard deviation, households can enjoy a 0.6% decrease in their relative price index. Households can also reduce their price level by choosing goods of lower quality or by shopping at discount shops. These effects, however, are smaller than the effects through purchasing at the bargain sales. The effects through frequency of shopping are only 20% of the effects of purchasing at bargain sales.

It is worth noting that the R-squared of Spec (1) in Table 6 is approximately 10%, which implies that approximately 90% of the differences in the relative price index cannot be explained by the observed variables. As shown in Figure 1 and Table 4, there is a significant amount of heterogeneity in the relative price index across households. We need more information on the households' shopping behaviors and preferences to study the cause of the heterogeneity in more detail.

6. Conclusion

This paper investigated household-level price and inflation rate differences based on Japanese scanner data. The data reveal that the law of one price is violated to a great extent, and differences in prices and inflation rates across households exist for the same commodity, and these results are consistent with previous studies based on US data. Both the price level and the inflation rate have a negative correlation with shopping frequency. However, the fixed effects estimates show very small significant effects of the shopping frequency on the price level. The largest effects come from the non-bargain ratio.

There are many remaining tasks. In this paper, the product-level information is not fully utilized. The variation in household characteristics, such as employment status and family composition, may also be important in explaining the differences in the inflation rates across households. Finally, following Broda and Romalis (2009), the heterogeneity in the movements of the price level, that is, the heterogeneity in household-level inflation, needs to be investigated.

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Table 1: Family Composition

Family members		2	3	4	5	6
	2004	0.16	0.24	0.38	0.15	0.07
SCI	2005	0.16	0.24	0.38	0.15	0.07
	2006	0.17	0.24	0.38	0.14	0.07
Census	2005	0.38	0.27	0.22	0.08	0.05
KHPS	2004–2009	0.22	0.24	0.29	0.14	0.11

Table 2: Wife Age Distribution

	Wife Age	～29	30～34	35～39	40～44
	2004	0.08	0.11	0.16	0.16
SCI	2005	0.08	0.12	0.14	0.16
	2006	0.08	0.12	0.14	0.15
Census	2005	0.068	0.107	0.111	0.11
	Wife Age	45～49	50～54	55～59	60～
	2004	0.12	0.14	0.11	0.12
SCI	2005	0.12	0.13	0.13	0.11
	2006	0.12	0.12	0.14	0.11
Census	2005	0.111	0.128	0.148	0.218

Table 3: Wife's job status

Age	SCI						Census 2005
	Full Time	Part Time	Self Employed	Agriculture	Sideline	Non Working	Non Working
～29	0.13	0.23	0.01	0.00	0.02	0.61	0.55
30～34	0.10	0.33	0.02	0.00	0.04	0.52	0.54
35～39	0.14	0.41	0.02	0.00	0.03	0.40	0.47
40～44	0.14	0.50	0.03	0.00	0.04	0.29	0.35
45～49	0.20	0.47	0.04	0.00	0.03	0.27	0.30
50～54	0.19	0.44	0.04	0.00	0.02	0.31	0.34
55～59	0.18	0.33	0.04	0.00	0.02	0.42	0.41
60～	0.09	0.19	0.06	0.00	0.02	0.64	0.50

Table 4: Basic Regression

	(1) lnprice	(2) lnprice	(3) lnprice	(4) lnprice
Dummy for Income (1)				
4,000–5,490	0.0016	0.0016	0.0011	0.0008
	(5.556)	(5.531)	(3.587)	(2.645)
5,500–6,990	0.0055	0.0055	0.0050	0.0049
	(17.462)	(17.424)	(15.962)	(15.606)
7,000–8,990	0.0069	0.0068	0.0060	0.0060
	(20.911)	(20.857)	(18.431)	(18.546)
9,000–	0.0130	0.0130	0.0119	0.0121
	(37.898)	(37.831)	(35.121)	(36.789)
Dummy for Age (2)				
30–34	−0.0025	−0.0025	−0.0024	−0.0035
	(−5.822)	(−5.809)	(−5.566)	(−8.283)
35–39	−0.0005	−0.0005	−0.0003	−0.0011
	(−1.177)	(−1.203)	(−0.723)	(−2.778)
40–44	−0.0021	−0.0021	−0.0019	−0.0011
	(−4.338)	(−4.354)	(−3.896)	(−2.647)
45–49	−0.0001	−0.0001	0.0002	0.0032
	(−0.241)	(−0.248)	(0.399)	(7.449)
50–54	0.0001	0.0001	0.0006	0.0051
	(0.234)	(0.206)	(1.050)	(11.861)
55–59	0.0023	0.0023	0.0028	0.0080
	(4.228)	(4.267)	(5.044)	(18.802)
60–	0.0078	0.0078	0.0080	0.0138
	(14.172)	(14.158)	(14.555)	(31.895)
Constant	−0.0042	−0.0036	−0.0031	−0.0096
	(−4.809)	(−5.419)	(−5.893)	(−27.102)
Observations	371,367	371,367	371,367	371,367
R-squared	0.031	0.031	0.018	0.015

Note:
Ordinary least squares estimates based on Japanese homescan provided by Intage.
The dependent variable is the natural logarithm of the relative price index.
The data is converted to household level monthly data.
(1) The unit is 1000yen. The base is the income below 4,000.
(2) The age of wife. The base is the dummy for below 30.
Spec (1) controlled for time dummies, locational dummies, and household characteristics.
Spec (2) controlled for locational dummies and household characteristics.
Spec (3) controlled for household characteristics.
All the explanatory variables in spec (4) are shown in this table.

Table 5: Descriptive Statistics

		lnprice		Price Index (Level)		lntrip		Number of Trips		lnstore	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
age of wife	～29	−0.0075	0.0595	0.9943	0.0590	2.0662	0.7512	10.1810	7.3054	1.2712	0.6101
	30～34	−0.0106	0.0572	0.9911	0.0566	2.1968	0.7486	11.4913	7.7730	1.3404	0.6121
	35～39	−0.0070	0.0572	0.9947	0.0567	2.3254	0.7387	12.9688	8.5863	1.3998	0.6004
	40～44	−0.0056	0.0571	0.9960	0.0567	2.4589	0.7505	14.8864	9.8937	1.4514	0.6051
	45～49	−0.0003	0.0564	1.0013	0.0563	2.5284	0.7340	15.7767	10.1449	1.4707	0.6006
	50～54	0.0027	0.0571	1.0044	0.0571	2.6112	0.6869	16.7191	10.3619	1.5510	0.5767
	55～59	0.0044	0.0573	1.0060	0.0573	2.5979	0.6526	16.1623	9.4398	1.5570	0.5784
	60～	0.0076	0.0584	1.0094	0.0587	2.5977	0.6516	16.1627	9.4465	1.5323	0.5809
	Total	−0.0021	0.0577	0.9995	0.0575	2.4349	0.7381	14.4381	9.5046	1.4515	0.6022
income	～4000	−0.0062	0.0594	0.9954	0.0669	2.3426	0.7376	13.1376	8.8552	1.3644	0.6032
	4000-5490	−0.0070	0.0577	0.9940	0.0638	2.3895	0.7294	13.6798	8.9383	1.4207	0.5938
	5500-6990	−0.0026	0.0573	0.9997	0.0636	2.4217	0.7432	14.2156	9.4528	1.4494	0.6012
	7000-8990	−0.0007	0.0567	1.0012	0.0619	2.4921	0.7453	15.2501	10.1186	1.4956	0.6007
	9000～	0.0073	0.0563	1.0104	0.0625	2.5430	0.7184	15.7681	10.0189	1.5371	0.5995
	Total	−0.0021	0.0577	0.9998	0.0640	2.4349	0.7381	14.3654	9.5090	1.4515	0.6022

		non_bargain		lnquantity		lnHHI		lnstore_choice		lnquality	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
age of wife (1)	～29	0.3149	0.1669	4.0852	0.6789	8.4072	0.4752	−0.1816	0.0753	−0.0518	0.1751
	30～34	0.3319	0.1662	4.2796	0.6544	8.3691	0.4848	−0.1784	0.0739	−0.0355	0.1753
	35～39	0.3470	0.1590	4.4645	0.6417	8.3649	0.4791	−0.1748	0.0768	−0.0244	0.1605
	40～44	0.3516	0.1567	4.6017	0.6465	8.3466	0.4837	−0.1714	0.0730	−0.0157	0.1548
	45～49	0.3550	0.1574	4.6544	0.6393	8.3459	0.4851	−0.1664	0.0779	−0.0008	0.1599
	50～54	0.3529	0.1567	4.6235	0.6232	8.2837	0.4829	−0.1584	0.0841	0.0005	0.1749
	55～59	0.3594	0.1613	4.5536	0.5903	8.2729	0.4854	−0.1541	0.0917	0.0016	0.1854
	60～	0.3720	0.1627	4.5348	0.5836	8.2979	0.4912	−0.1501	0.1133	−0.0034	0.1842
	Total	0.3492	0.1611	4.4945	0.6539	8.3344	0.4853	−0.1668	0.0841	−0.0150	0.1713
income (2)	～4000	0.3396	0.1638	4.3503	0.6523	8.3812	0.4816	−0.1745	0.0839	−0.0494	0.1730
	4000-5490	0.3447	0.1602	4.4441	0.6405	8.3507	0.4774	−0.1729	0.0808	−0.0305	0.1685
	5500-6990	0.3545	0.1625	4.5026	0.6582	8.3399	0.4824	−0.1682	0.0766	−0.0130	0.1640
	7000-8990	0.3518	0.1595	4.5772	0.6418	8.3129	0.4878	−0.1618	0.0903	0.0006	0.1670
	9000～	0.3561	0.1588	4.6117	0.6462	8.2818	0.4938	−0.1548	0.0883	0.0218	0.1762
	Total	0.3492	0.1611	4.4945	0.6539	8.3344	0.4853	−0.1668	0.0841	−0.0150	0.1713

Note

(1) The age of wife. The base is the dummy for below 30.

(2) The unit is 1000yen. The base is the income below 4,000.

Table 6: Ordinary Least Squares

	(1) lnprice	(2) lnprice	(3) lnprice	(4) lnprice	(5) lnprice	(6) lnprice	(7) lnprice	(8) lnprice
lntrip	−0.0137	−0.0126						
	(−56.881)	(−92.771)						
lnstore	0.0029		−0.0087					
	(8.940)		(−52.931)					
lnHHI	−0.0038			0.0067				
	(−11.745)			(34.013)				
lnquantity	−0.0029				−0.0140			
	(−12.331)				(−87.747)			
non_bargain	0.0552					0.0463		
	(85.180)					(72.912)		
lnstore_choice	0.0340						0.0594	
	(28.385)						(52.549)	
lnquality	0.0476							0.0557
	(81.741)							(101.984)
Dummy for Income (1)								
4,000−5,490	0.0009	0.0018	0.0020	0.0018	0.0019	0.0019	0.0013	0.0006
	(3.099)	(6.266)	(6.806)	(6.255)	(6.535)	(6.355)	(4.447)	(2.182)
5,500−6,990	0.0036	0.0054	0.0059	0.0057	0.0057	0.0058	0.0049	0.0037
	(11.904)	(17.500)	(18.919)	(18.272)	(18.331)	(18.400)	(15.670)	(11.854)
7,000−8,990	0.0047	0.0070	0.0075	0.0072	0.0073	0.0075	0.0059	0.0044
	(14.908)	(21.535)	(22.894)	(22.101)	(22.514)	(22.881)	(18.066)	(13.599)
9,000−	0.0099	0.0129	0.0137	0.0135	0.0134	0.0138	0.0118	0.0097
	(29.770)	(38.060)	(39.877)	(39.273)	(39.404)	(40.447)	(34.394)	(28.547)
Dummy for Age (2)								
30−34	−0.0024	−0.0011	−0.0019	−0.0022	−0.0007	−0.0030	−0.0029	−0.0033
	(−5.594)	(−2.531)	(−4.483)	(−5.056)	(−1.678)	(−6.882)	(−6.606)	(−7.733)
35−39	0.0004	0.0024	0.0007	−0.0000	0.0031	−0.0014	−0.0011	−0.0017
	(0.999)	(5.297)	(1.491)	(−0.097)	(6.764)	(−3.020)	(−2.463)	(−3.704)
40−44	−0.0001	0.0023	−0.0004	−0.0014	0.0029	−0.0031	−0.0030	−0.0036
	(−0.212)	(4.702)	(−0.776)	(−2.937)	(5.868)	(−6.279)	(−6.067)	(−7.487)
45−49	0.0016	0.0049	0.0018	0.0005	0.0057	−0.0016	−0.0011	−0.0022
	(3.051)	(9.309)	(3.307)	(0.965)	(10.720)	(−2.938)	(−2.047)	(−4.211)
50−54	0.0026	0.0061	0.0025	0.0010	0.0067	−0.0018	−0.0009	−0.0014
	(4.839)	(11.296)	(4.632)	(1.813)	(12.256)	(−3.277)	(−1.604)	(−2.695)
55−59	0.0037	0.0085	0.0048	0.0032	0.0091	−0.0003	0.0011	0.0004
	(6.893)	(15.601)	(8.816)	(5.889)	(16.642)	(−0.606)	(2.084)	(0.765)
60−	0.0085	0.0141	0.0100	0.0085	0.0150	0.0047	0.0062	0.0055
	(15.697)	(25.785)	(18.288)	(15.528)	(27.302)	(8.549)	(11.373)	(10.084)
Constant	0.0524	0.0221	0.0070	−0.0606	0.0509	−0.0222	0.0069	−0.0004
	(17.102)	(24.560)	(7.871)	(−32.397)	(47.972)	(−24.819)	(7.766)	(−0.509)
Observations	371,367	371,367	371,367	371,367	371,367	371,367	371,367	371,367
R−squared	0.098	0.053	0.038	0.034	0.050	0.044	0.038	0.057

Note:
Ordinary least squares estimates based on Japanese homescan provided by Intage.
The dependent variable is the natural logarithm of the relative price index.
Time dummies are included in all the specifications. T statistics are in parentehes.
Household level charcteristics such as the number of family members as well as locational information are also controlled.
The data is converted to household level monthly data.
(1) The unit is 1000yen. The base is the income below 4,000.
(2) The age of wife. The base is the dummy for below 30.

Table 7: Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	lnprice	lnprice	lnprice	lnprice	lnprice	lnprice	lnprice	
lntrip	0.0027	−0.0024						
	(8.603)	(−12.230)						
lnstore	0.0019		−0.0008					
	(6.523)		(−4.196)					
lnHHI	−0.0014			0.0012				
	(−4.663)			(5.105)				
lnquantity	−0.0108				−0.0098			
	(−37.399)				(−45.968)			
non_bargain	0.0594					0.0567		
	(99.182)					(96.201)		
lnstore_choice	0.0163						0.0205	
	(13.531)						(17.452)	
lnquality	0.0190							0.0236
	(34.243)							(44.338)
Dummy for Income (1)								
4,000−5,490	0.0001	−0.0001	−0.0001	−0.0001	−0.0001	0.0001	−0.0001	−0.0001
	(0.171)	(−0.111)	(−0.103)	(−0.098)	(−0.096)	(0.153)	(−0.085)	(−0.128)
5,500−6,990	0.0003	0.0001	0.0002	0.0002	0.0001	0.0003	0.0002	0.0002
	(0.435)	(0.191)	(0.240)	(0.229)	(0.111)	(0.464)	(0.270)	(0.257)
7,000−8,990	0.0007	0.0006	0.0006	0.0006	0.0005	0.0008	0.0007	0.0005
	(0.898)	(0.687)	(0.751)	(0.749)	(0.565)	(0.998)	(0.817)	(0.676)
9,000−	0.0001	0.0000	0.0001	0.0001	−0.0001	0.0002	0.0001	0.0001
	(0.157)	(0.036)	(0.121)	(0.118)	(−0.055)	(0.266)	(0.142)	(0.056)
Dummy for Age (2)								
30−34	0.0010	0.0011	0.0012	0.0013	0.0013	0.0008	0.0012	0.0013
	(1.403)	(1.636)	(1.776)	(1.784)	(1.814)	(1.141)	(1.759)	(1.804)
35−39	0.0017	0.0018	0.0019	0.0020	0.0020	0.0016	0.0019	0.0018
	(1.692)	(1.762)	(1.889)	(1.907)	(1.933)	(1.611)	(1.830)	(1.778)
40−44	0.0021	0.0021	0.0022	0.0022	0.0024	0.0020	0.0021	0.0020
	(1.787)	(1.729)	(1.809)	(1.828)	(2.001)	(1.695)	(1.722)	(1.640)
45−49	0.0029	0.0029	0.0030	0.0030	0.0031	0.0030	0.0029	0.0028
	(2.129)	(2.092)	(2.158)	(2.181)	(2.243)	(2.184)	(2.068)	(1.998)
50−54	0.0033	0.0030	0.0031	0.0031	0.0032	0.0034	0.0030	0.0029
	(2.062)	(1.862)	(1.912)	(1.938)	(1.958)	(2.120)	(1.825)	(1.819)
55−59	0.0026	0.0025	0.0025	0.0026	0.0027	0.0029	0.0023	0.0023
	(1.491)	(1.410)	(1.421)	(1.446)	(1.517)	(1.638)	(1.277)	(1.293)
60−	0.0036	0.0035	0.0035	0.0035	0.0036	0.0039	0.0032	0.0032
	(1.796)	(1.716)	(1.706)	(1.731)	(1.806)	(1.926)	(1.578)	(1.595)
Constant	0.0266	0.0004	−0.0045	−0.0153	0.0376	−0.0256	−0.0021	−0.0047
	(8.528)	(0.278)	(−3.140)	(−6.520)	(22.468)	(−18.462)	(−1.510)	(−3.374)
Observations	371,367	371,367	371,367	371,367	371,367	371,367	371,367	371,367
R−squared	0.038	0.001	0.001	0.001	0.006	0.026	0.001	0.006
Number of Families	14,442	14,442	14,442	14,442	14,442	14,442	14,442	14,442

Note:
Linear Fixed Effects estimates based on Japanese homescan provided by Intage.
The dependent variable is the natural logarithm of the relative price index.
Time dummies are included in all the specifications. T statistics are in parentehes.
Household level charcteristics such as the number of family members are also controlled.
The data is converted to household level monthly data.
(1) The unit is 1000yen. The base is the income below 4,000.
(2) The age of wife. The base is the dummy for below 30.

Table 8: The effects of an increase by one standard deviation of each variable on ln (Prices)

	lntrip	lnstore	lnHHI	lnquantity	non_bargain	lnstore_choice	lnquality
SD	0.73807	0.60218	0.48529	0.65390	0.16107	0.08413	0.17129
Coefficients	−0.0024	−0.0008	0.0012	−0.0098	0.0567	0.0205	0.0236
Effects on ln Prices	−0.00177	−0.00048	0.00058	−0.00641	0.00913	0.00172	0.00404

Note

Based on Fixed Effects Models in Table 7.

SD is one standard deviation of each variable.

The standard deviation of ln (Prices) is 0.0577.