Micro and Macro Price Dynamics over Twenty Years in Japan
— A Large Scale Study Using Daily Scanner Data — [1]

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Abstract

Using large-scale daily scanner data, we investigate micro and macro price dynamics in Japan between 1988 and 2005. Drawing upon three billion observations of prices and the number of sold units, we find: (i) the frequency of price change is increasing, (ii) the frequency varies greatly between products and stores, and (iii) the choice of data frequency is crucial when estimating the degree of price stickiness. The estimates obtained with daily data are very different from those employing monthly data. Moreover, (iv) a Consumer Price Index (CPI) based on scanner data exhibits similar movements to the official CPI, except for the first half of the 1990s and in the 2000s, (v) the lower substitution bias does not comprise a serious problem, and (vi) the scanner-based CPI is more strongly correlated with the GDP gap than the official CPI. Our findings of the increasing frequency of price changes and very flexible prices are inconsistent with New Keynesian models of the Phillips Curve and recent Japanese experience with the flattening of the Phillips Curve. The second and third findings cast doubt on the use of monthly data to estimate the degree of price stickiness.

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1. Introduction

Investigation of the price dynamics of individual commodities and their aggregates, such as the Consumer Price Index (CPI), has been a central theme of modern macroeconomics. For a long time, researchers have been seeking theories that can describe and predict the price dynamics, statistical indicators that can capture the aggregate movement of prices, and policy tools that enable policymakers to control inflation. Recently, an increasing number of researchers and policymakers have made use of scanner data to analyze price dynamics because of their rich information on prices and the amount of sales.

Compared with the monthly surveys of prices conducted by many governments, including the Bureau of Labor Statistics (BLS), scanner data contains much more information on the prices of a greater number of different commodities at higher frequencies. Unfortunately, only a few food retail chain stores in a particular city provide most of the scanner data available to researchers. This is far from the nationwide representative sample included in collections such as the BLS micro price data.[4]

In this paper, we employ a large-scale daily scanner data in Japan. The data comprises 280 different food stores, including general merchandize stores (GMS), food markets, and convenience stores, throughout Japan. With this

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[4] The Chicago Graduate Business School provides store-level weekly scanner data from 86 stores in the Dominick's Finer Foods retail chain in the Chicago area. See Chevalier, Kashyap

data, we investigate both the micro and macro price dynamics in Japan over a period of 20 years. More specifically, we investigate the frequency of price changes and the characteristics of aggregate prices based on the scanner data.

The degree to which prices are sticky is a key parameter when evaluating the effects of monetary policy in the latest macroeconomic models. In both time-dependent models, such as those by Taylor (1980) and Calvo (1983), and state-dependent models including Caplin and Spulber (1987) and Golosov and Lucas (2007), a crucial ingredient of price dynamics is the reluctance or inability of price setters to change prices. Because these models assume that individual prices are sticky, an increasing number of researchers in price behavior have used micro data to investigate the frequency of price adjustment.[5]

Until now, many empirical analyses of price dynamics have used monthly data. For example, Bils and Klenow (2004) and Nakamura and Steinsson (2007) used monthly data in the US, Dhyne, et al. (2005) used monthly data in Europe, and Saita and Higo (2007) used Japanese monthly data. Although the estimates of the frequency of price changes in these studies differ, the estimated monthly frequencies are generally smaller than 0.3, implying that prices do not change, on average, for three months. Recently, Kehoe and

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and Rossi (2003) and Kehoe and Midrigan (2007) for examples of research based on this data.

[5] The number of studies concerning micro price dynamics is increasing. See Dyhne et al. (2005), and Baharad and Eden (2004) for recent progress is this area.

Midrigan (2007) utilized weekly data from a single food retail chain in Chicago and found that the weekly frequency of price changes was 0.33, suggesting that the average duration for which prices remain unchanged is only 3 weeks.

Although the sample used by Kehoe and Midrigan (2007) is very different from that employed by Bils and Klenow (2004) or Nakamura and Steinsson (2007) in many respects, we suspect that a crucial factor that creates these significant discrepancies are the differences in data frequency. Our estimates of the price change frequency based on daily scanner data are much lower than in Kehoe and Midrigan (2007), even after controlling for the effects of bargain sales. The frequency of data becomes crucial in estimating the average length of price change duration when there is strong heterogeneity among price setters. In this paper, we investigate the role of data frequency and heterogeneity among stores when estimating the price change frequency.

The second objective of this paper is to investigate macro price dynamics in Japan. Japanese experience of aggregate price dynamics following the "bubble" period is unique in several aspects. Figure 1 shows changes in the growth rate of the official Japanese CPI.[6] In this figure, we observe both inflation and deflation in the 1990s.[7] Since the late 1990s, the Japanese economy is characterized by (1) persistent deflation, (2) long-term recession, and (3) a

[6] Sudden increases in prices in 1989 and 1995 were the result of changes in consumption taxes.

[7] Shiratsuka (1998; 1999) provided excellent surveys on the possible bias in the Japanese CPI.

flattening Phillips Curve.[8] Note that the Japanese economy went into recession in the early 1990s, while the CPI kept rising until the late 1990s. Partly inspired by the Boskin reports (Advisory Commission to Study the Consumer Price Index, 1996), academic and nonacademic researchers alike have serious doubts about the precision of the official CPI in Japan particularly during the early 1990s.[9]

In Section 4 in this paper, we construct a CPI based on the scanner data and compare it with the official CPI. Scanner data has several advantages for constructing CPI over official monthly surveys. First, because scanner data contains information on the number of units sold, we can use a Paasche or chain index that is free from the upward bias found in the Laspeyres Index. Second, because the scanner data covers almost all items in the same category, it is free from the lower substitution bias pointed out in the Boskin report (1996). Finally, scanner data contains information on bargain sales, not included in the official monthly survey.

Our basic findings on Japanese micro and macro price dynamics are as follows:

1) Prices change very frequently. Most products change their prices within 1 week;

The Saison Research Institute (2001) report their own estimates of the CPI based on point-of-sale (POS) data provided by a supermarket chain in Tokyo.

[8] See Miyao(2001) and Sakura, Sasaki and Higo(2005) for recent analyses of the Phillips Curve

2) The frequency of change varies greatly between products and stores;

3) Even after excluding price changes related to bargain sales, prices are much more flexible than indicated by previous estimates based on monthly data;

4) When we transform our daily price data to monthly data, we obtain similar frequencies of price change to those in earlier research;

5) The frequency of price changes is not constant over time, but increasing;

6) The movements in the CPI based on our data are similar to the official CPI except during the early 1990s;

7) The deflation of the early 1990s of the CPI based on our data is not caused by lower substitution biases;

8) The CPI based on our data has a higher correlation with the GDP gap than the official CPI.

The results of this analysis have several major implications. To start with, very flexible price movement cast doubts on the standard assumption in many macroeconomics models that individual prices are sticky. For instance, an increasing trend in price change frequency is inconsistent with time-dependent models such as Calvo (1983), where the frequency is assumed constant. The existence of an upward trend also casts doubts on the New Keynesian Phillips Curve because an increase in price change frequency should make the Phillips Curve steeper; this lies exactly opposite to recent Japanese experience. The

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in Japan.

discrepancies in the estimates of price change frequencies between daily and monthly data suggest the existence of a serious upward bias when using monthly data is used.

This paper is organized as follows. Section 2 provides a brief description of the data. Section 3 discusses the frequency of price changes and bargain sales. Section 4 explores the implication of our estimates of price dynamics for the Japanese CPI. Section 5 concludes.

2. The Data

We use a POS dataset compiled by Nikkei Digital Media (Nikkei-POS). Nikkei or Nihon Keizai Shinbun (Japan Economic Times) is one of the largest providers of economic datasets in Japan including company information, stock prices, and macroeconomic data. Nikkei-POS is a commercial product. The Nikkei-POS includes 18 years of data covering the period from March 1, 1988 to December 31, 2005.[10] The data provides daily transactions for a large number of products by various retail shops, including GMS and supermarkets throughout Japan.[11] The number of products recorded exceeds one million, and the total number of observations is about three billion. The Nikkei-POS contains processed foods and domestic articles as item categories.

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[9] See International Labor Organization (2005) for details.
[10] Unfortunately, the data does not contain observations for November and December 2003.
[11] The data includes large chain stores such as Daiei and Mycal along with smaller

Unfortunately, information on fresh foods, services, and expensive durable goods are not available.[12]

Table 1 shows the basic characteristics of the data. We observe that each year, transactions for approximately 0.2 million different products are recorded in the data. Because the average annual total sales per store is about 1.3 billion yen (some 12 million US dollars), this implies the stores included in the survey are not very small. Table 2 reports the location distribution of the sample stores. We can confirm that the stores are located throughout Japan.

In Figures 2 (a), (b), and (c), we show some examples of the movements of prices and the number of units sold as recorded in our data. The commodity employed as an example is Nissin's Cup Noodle, which is well known in Japan and is one of the components of the Japanese CPI compiled by the Statistics Bureau. The figures illustrate the records for three typical stores in our datasets from September 1, 2005 to December 31, 2005. As shown, the store illustrated in Figure 2(a) frequently changed prices, although without following a clear pattern, whereas the store in Figure 2(b) did not change prices at all. The store in Figure 2(c) changed priced periodically. Occasionally we observe very different pricing patterns, even for the retailers in the same chain.

The Nikkei-POS contains the JAN code as one of the identifiers for each

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convenience stores.

[12] Detailed categories of processed foods and domestic articles and their annual sales amounts are denoted in Appendix Table 1.

product. In principle, the JAN code is a unique product identifier; that is, different products have different JAN codes. In reality, some companies use the same JAN code for similar C products. To deal with this problem, Nikkei creates an additional identifier, the generation code, for each JAN code. We use a combined product code that is a mixture of the JAN code and the generation code.

3. The Frequency of Price Changes and Bargain Sales

3.1. The Frequency of Price Changes

Figure 3 shows the daily frequencies of price changes in the Nikkei-POS each year. The price change frequencies are calculated by: (i) rounding prices off below the decimal point to remove the effects of time sales within each day, (ii) taking the means of dummy variables that take a value of unity when the price is different from the day before, (iii) calculating the item category level frequencies using the weighted average of item level frequencies with sales weights, and (iv) calculating the total level frequencies by weighted average of item category level frequencies by sales weights. Note that we remove samples that are not sold over 300 days per store when we calculate the frequencies.

In Figure 3, we can observe that the total daily frequency is about 14% in 1988, 20% in 2000, and 34.6% in 2005. That is, price changes occur once every 3 days in 2005. Table 3 reports more detailed frequencies at the categorical

level. In all categories, we can observe increasing trends in price change frequency. We also confirm that there is great amount of heterogeneity in price change frequencies among the various products.

Figure 4 shows the standard deviations of the frequencies across stores. This reveals that the price change frequency varies greatly across stores. As for the average frequency in Figure 3, the heterogeneity also displays an increasing trend.[13]

The followings summarize the information in Figures 3 and 4:

1) Prices change very frequently. Many products experience price change within a week;

2) There are upward trends in the frequency of price changes;

3) The frequencies of price changes vary greatly between commodities;

4) The standard deviation of price changes among stores is large, implying very heterogeneous price-setting behavior between stores.

These observational facts differ significantly from the estimates obtained in previous work. For example, Bils and Klenow (2004) and Nakamura and Steinsson (2007) estimated that the average spell during which prices remain unchanged to be about 4 to 5 months. Using Japanese data, Saita and Higo (2007) showed that the average frequency of monthly price changes of goods is about 33.5% that is, the average spell during which prices remain unchanged is

[13] Appendix Table 2 reports the standard deviations for more detailed categories.

about 3 months. Our estimates are substantially shorter than previous results based on monthly data.

3.2. The Frequency of Regular Price Changes

As Kehoe and Midrigan (2007) and Nakamura and Steinsson (2007) stressed, identifying regular price changes from changes due to bargain sales is crucial when estimating the price change frequency. Unfortunately, our scanner data do not contain an explicit identifier of bargain sales. Therefore, we are obliged to create a filter to identify regular price changes and bargain sales. Among the many candidate filters, such as the maximum value of prices, the AC Nielsen algorithm, and so on, we adopt the weekly mode price as the regular price. That is, we regard very frequent price changes that occur within a week as changes arising from bargain sales. We ignore these price changes. The official CPI in Japan and the CPI manual by the ILO (2005) adopt a similar definition of bargain sales. By construction, regular prices then do not change in less than 1 week.

The frequencies of changes in regular prices are reported in Figure 5. As is clear from the figure, the average frequencies are substantially lower than those using raw prices in Figure 3. The daily frequencies of price changes are between 2.5% and 4.5%; that is, changes in the regular price occur once every 20-40 days on average. Although this means the regular prices are sticky, our

regular prices are much more flexible than previous estimates by Nakamura and Steinsson (2007). Secondly, and similar to Figure 3, we can observe a positive trend in the frequency of regular price changes. Table 4 reports the frequencies of regular price changes for each product category.

Figure 6 shows the standard deviations for frequencies of regular price changes across stores. Similar to Figure 4, the figure reports a great degree of heterogeneity in the regular price change frequencies. We can also observe an upward trend in the heterogeneity.[14]

The followings summarize the information shown in Figures 5 and 6:

1) Regular prices do not change as rapidly as raw prices;

2) Similar to raw prices, we observe an upward trend in the frequency of regular price changes;

3) The frequencies of regular price changes vary greatly between commodities;

4) We can observe very heterogeneous regular-price-setting behavior between stores.

3.3. Data Frequency and the Frequency of Price Changes

So far, and based on scanner data, we have shown that prices change considerably more rapidly than the previous estimates based on monthly surveys by Saita and Higo (2007). In this subsection, we investigate the cause

[14] Refer to Appendix Table 3 for the standard deviations of regular price change frequencies for

of this huge discrepancy.

Our estimates of the regular price change frequency are about 20-40 days. This implies that if we use monthly data, the estimates of monthly price change frequencies should lie close to unity. This is not the case. Based on our daily scanner data, we can construct monthly data that is close to the price data in the official CPI. More specifically, we can generate monthly data by selecting the price of the sample on the Wednesday of the week including the 15th day of the month. Similarly to the official CPI, we select the prices of the most popular goods only for each category over all of the stores. We can then obtain monthly price data that is close to the official CPI.

Figure 7 reports the monthly price change frequencies based on the monthly transformed data. According to this figure, the average spell during which prices remain unchanged is about 3.8 months in 1988 and 2.5 months in 2005. Figure 8 reports the results of the same estimation using the regular price data: these exhibit longer spells of 5.3 months in 1988 and 3.5 months in 2005. Refer to Table 5 for the monthly frequency of regular price for more detailed categories.[15] The estimated lengths of duration are too different from the previous estimates based on monthly data. For example, Nakamura and Steinsson (2007) estimate 4-5 months in the US and Saita and Higo (2007) estimate 3 months in Japan.

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each product category.

One possible reason for the inconsistency in the price change frequencies between daily and monthly data is heterogeneity in price-setting behavior between stores. Suppose that 50% of the firms change their prices every other day, while the remaining 50% of firms never change their prices. If we use monthly data, after 1 month has passed, 50% of firms have changed their prices while the other 50% of firms have not. Therefore, the estimated average spell during which prices remain unchanged is 2 months; that is to say, the monthly frequency of price changes in this case is 50%. If we use weekly data, after 1 week has passed, 50% of firms have changed their prices while the remaining 50% have not. Consequently, the estimated average spell is 2 weeks; that is, the weekly frequency of price changes is again 50%. Finally, if we use daily data the estimated average spell becomes 4 days. As shown in Figures 4 and 6, strong heterogeneity in price setting behavior between stores exists in our sample. This implies that the data frequency is crucial when estimating the frequency of price changes.

3.4. Bargain Sales

In this subsection, we investigate the characteristics of the price changes resulting from bargain sales. We consider that the product is on sale when the price is below the regular price; that is, it is below the store weekly mode price

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[15] See Appendix Table 4 for the monthly frequencies of raw prices for each product category.

constructed in the previous section.[16]

Figure 9 shows the frequencies of bargain sales. The bargain frequency of processed foods in 2005 is 17.0%, implying that the products are on bargain sale once every 6 days. For domestic articles, the frequency is 12.6%; products are on bargain sale once every 8 days. Again, we can observe an upward trend in the sales frequencies. Table 6 reports the frequencies of bargain sales for more detailed categories. Apparently, the bargain frequency varies among the various product categories.

Figure 10 reports the ratio of the amount of selling during bargain sales to the amount of total selling. This illustrates the relative importance of bargain sales. The bargain sales ratio is gradually rising and reached to 23.3% in 2005. That is, significant amounts of transactions occur during bargain sales.[17] Note that because the official CPI excludes information on sales, it implies that the CPI excludes information on about 25% of the total expenditure on products. In addition, it is worth noting that both bargain sales frequency and the bargain sales ratio have been rising.

4. Construction of CPI Based on Scanner Data

The official CPI in Japan has been criticized for its lack of precision since

[16] Sometimes, we encounter prices that are not integers, such as 112.54 yen. This may arise from typing errors, price variations within a day, buy one-get-one-for-free sales, etc. Because we cannot be sure of the exact cause, we round all prices to the nearest integer.

the mid-1990s severely. Shiratsuka (1995; 1998) have pointed out several shortcomings of the Japanese CPI.[18] The many possible sources of bias include: (1) a lack of information about bargain sales, (2) lower substitution bias, (3) a downward bias caused by use of the Laspeyres Index, and (4) the selection of surveyed stores.

When constructing the CPI by using scanner data, we can avoid some of the criticisms raised by Shiratsuka (1995; 1998). To start with, we can include information on bargain sales. Because our data contains the information on the quantity of units sold, we can also construct the Paasche or chain index so that we do not have to fix the weight. We can also avoid the lower substitution bias because we can potentially use all of the commodities sold in each category.

4.1. The Quantity Weighted Average Price and the Mode Price

In this subsection, we introduce two price index concepts. The first is the quantity-weighted average price index where bargain sales are considered. The second is the mode price index where only the regular price is included. The quantity-weighted average price is calculated by taking the average sales price

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[17] Appendix Table 5 shows the bargain sales ratios for more detailed product categories.

[18] The official CPI in Japan is constructed by the Statistical Bureau following the CPI manual by ILO (2005). The price survey is administrated every month on the Wednesday, Thursday, or Friday of the week that includes the 12th day of the month. In the survey, prices with durations shorter than 7 days are excluded as bargain sales. The number of items surveyed is limited to 584. The representative commodity in each category is selected from the viewpoint of continuance and the representative character. As the CPI is a Laspeyres Index, the weight is only altered every 5 years.

every day in each store using the quantity sold as the weight. The mode price index is constructed by taking the weekly mode price of each store.[19]

Two time-series of aggregate inflation rates are calculated by the chain index method using the quantity-weighted average and mode prices. More specifically, we first obtain two time-series of monthly data for the quantity-weighted average and mode prices. Next, if the item exists in both the current month and the same month 1 year before, we calculate the rate of annual price change. Finally, we take the average rate of price change across all items and categories using the total sales amount 12 months before as the weight.

Figure 11 reports the aggregate inflation rates of the official CPI and the two CPI constructed in this study- the weighted means and mode indexes based on scanner data.[20] The figure shows that the three CPI are quite similar to each other except for just a few periods.[21] One difference can be observed during the early 1990s when our POS-based CPI indicated deflation while the official CPI showed inflation. We can also observe a departure between the official CPI and our indexes during the early 2000s. In the early 1990s, the degree of deflation in the quantity-weighted average prices including the

[19] See the Appendix for details.

[20] Our scanner data does not contain the prices of services, utilities, fresh foods, expensive durable goods, and rents. The Nikkei POS data covers 37.8% of all household expenses on goods that can be purchased in retail stores. This corresponds to 16.8% of total household expenses.

[21] The ups and downs in the official CPI in 1993 and 1994 were caused by the sharp rise and

effects of bargain sales is larger than in regular prices. The difference between the official CPI and our index in the early 1990s is greater for domestic articles than processed foods.[22]

The followings summarize the comparison of the official and scanner-based CPI:

1) Our scanner-based CPI can generally reproduce the rate of price change in the official CPI;

2) The rate of change in the CPI based on the regular (mode) price moves more closely to the rate of change in the CPI based on the quantity-weighted average price than the rate of change in the official CPI;

3) Our CPI based on the POS indicated deflation in the first half of the 1990s while the official CPI continued to exhibit inflationary tendencies;

4) Conversely, during the 2000s, the official CPI tended to exhibit deflation more severely than the CPI based on the scanner data.

4.2. Lower Substitution and Bargain Sale Bias

The rate of change in our CPI based on the scanner data consists of not only the rates of price change of one representative commodity in each category,

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fall in rice prices.

[22] If the rate of price change in the CPI based on the scanner data captures the true inflation rate, the real rate of interest wages at this time are considerably higher than the current estimates based on the official CPI. There is the possibility that the high levels of real interest and wage rates were one of the causes of the low growth period during the 1990s, known in Japan as the “lost decade”.

but also those of many alternative items in each category. Since the Boskin report (1996), the reliance of the CPI on the representative item has been criticized as a source of the lower substitution bias. The lower substitution bias occurs when consumers shift their demand from the representative items adopted by the CPI to other items with lower prices. Because the official CPI considers only the representative commodity in each category, the decline in the average prices consumers experience is not recorded in the official CPI.[23] In this subsection, we examine the degree of lower substitution bias based on scanner data in Japan.

Another possible important source of bias in the official CPI raised by previous studies is the exclusion of items sold during bargain sales. If more and more goods are sold during bargain sales, the average price level consumers face will decrease. The official CPI, however, fails to capture the decline because the CPI ignores the effects of bargain sales.

Figure 12(a) reports the comparison of the rate of price change for "instant noodle" in the official CPI with the rate of price change for "Nissin Cup Noodle". "Nissin Cup Noodle" is the item adopted in the official CPI. It is also the most sold item in this category in our scanner data. While instant noodle in the official CPI exhibits neither inflation nor deflation, "Nissin Cup Noodle" in the Nikkei-POS experiences deflation during the first half of the 1990s. In the

[23] It provides an upward bias from the true price in the official CPI. The Boskin report (1996)

early 2000s, while instant noodle in the official CPI fell into severe deflation, the deflation of "Nissin Cup Noodle" in the Nikkei-POS remained mild. We suspect that these discrepancies occur because the official CPI does not capture the prices sold at bargain sales.

In order to investigate the effects of lower substitution bias and the effects of bargain sales, we compare the rate of price change for "Nissin Cup Noodle", a product bundle that consists of the upper 5% of items in terms of the total sales and the entire items in the category of instant noodle.

From Figure 12(a), we can observe that the movement of the bundle of the upper 5% of items is extremely similar to that for all items in this category. In addition, though "Nissin Cup Noodle" experienced deflation more frequently than all other items, the total rate of price change is lower than for the official CPI. Therefore, the difference between the rate of price change for instant noodle in the official CPI and the rates of price changes for all products is brought about not by the lower substitution bias, but rather by the exclusion of bargain sales in the official CPI.

In Figure 12 (b), movements in the rate of change for the mode price of "Nissin Cup Noodle" trace those for instant noodle in the Official CPI very well until the end of the 1990s. The movements of regular prices of the upper 5% of items and all items also trace the official CPI well. Therefore, we can surmise

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emphasizes the significance of this bias.

that the lower substitution bias is not important in terms of the regular price during this period. We can also observe that in the early 1990s, the departure between the official CPI and scanner-based CPI arises from the exclusion of bargain sales in the official CPI because our mode price traces the movement of the official CPI. In the 2000s, however, the aggregated mode price traces the official CPI very poorly.[24]

Figure 13 shows the lower substitution effect in all categories. This figure indicates that it was bargain sales effects, not the substitution effect, which played an important role in the deflation of the 1990s. Figure 14 shows the average inflation rates during the post bubble period (after March 1991) in the official CPI and our CPI for processed foods and domestic articles. The average price down rate of the most sold item is larger. This indicates that the lower substitution bias was not a serious problem in the official Japanese CPI during the post bubble period.

4.3. The Correlation with GDP Gaps

In this subsection, we examine the relationship between scanner-based CPI and the GDP gap. Figure 15 plots our CPI, the official CPI, and the GDP gap in Japan.[25] Because our CPI includes information on changes in the

[24] The cause of the departure is not clear. Further investigation is required .

[25] We estimate the GDP gap from the log of real GDP data using the Hodrick-Prescott filter ($\lambda = 1600$).

frequency of bargain sales and changes in sales quantities, it is expected that our CPI is more sensitive to economic fluctuations than the official CPI.

Figure 16 shows the cross-correlations between the inflation rates of these price indexes and the GDP gap. In both (a) processed foods and domestic articles and (b) processed foods excluding cereals, our CPI has a higher correlation with the GDP gap and smaller lags than the official CPI. Table 7 reports the cross-correlations table between the inflation rates and the GDP gap with significance test statistics. In lag terms, we can observe significant correlations for both our CPI (denoted as POS) and the official CPI with the GDP gap, though in lead terms the level of significance is low. The correlation between the CPI based on POS and the GDP gap is 0.58 for a one-quarter lag, while the highest correlation value for the official CPI is 0.52 for a two-quarter lag. Therefore, we can generally observe that our CPI based on scanner data has a higher correlation with the GDP gap than the official CPI. This is probably because our CPI contains more information on bargain sales and the quantity sold on sale.

5. Concluding Remarks

In this paper, we investigated both micro and macro price dynamics using large-scale daily scanner data in Japan. We found:

1) Prices change very frequently. Most products change their prices within 1

week;

2) The frequency varies greatly between products and stores;

3) Even excluding price changes related to bargain sales, prices are much more flexible than indicated by previous estimates based on monthly data;

4) Monthly data constructed using our data for only a particular day in a month shows almost the same frequency of price change as previous research;

5) The frequency of price changes is increasing, not constant over time;

6) Movements in the CPI based on our data are similar to the official CPI except during the early 1990s;

7) Our analysis indicates that the deflation of the early 1990s was not caused by lower substitution bias. Rather, it is mainly the result of by bargain sales;

8) The CPI based on our data has a higher correlation with the GDP gap than the official CPI.

Our results cast doubts on the standard assumption adopted by many New Keynesian models that the aggregate price is sticky because individual prices are sticky. Importantly, our research raises the question of why the aggregate price is sticky although individual prices are not.

We have also shown the possibility that the official CPI fails to capture the true inflation rates in the early 1990s. Our scanner-based CPI suggests that the true inflation rate fell into deflation during this period. This implies that real interest rates and real wage rates were higher than previous estimates

based on the official CPI. Because the official CPI is an important indicator for policymakers such as the central bank, the failure of the official CPI to capture deflation may have lead the central bank make errors in their timing of monetary policy. Quantitative evaluation of these causalities is to be investigated by the authors in the near future.

APPENDIX: Definitions and Procedures

A.1. The Quantity-Weighted Average Price (Daily)

The price of the weighted average by sales quantity for an item $i \in I$ in a day td is defined by:

$$P_{i,td}^{Weight} = \sum_{s \in S} \frac{Q_{i,td}^{s}}{\sum_{s \in S} Q_{i,td}^{s}} P_{i,td}^{s},$$

where $P_{i,td}^{s}$ is the price for the item $i \in I$ sold at the store $s \in S$ in the day td. $Q_{i,td}^{s}$ is the quantity for the item $i \in I$ sold at the store $s \in S$ in the day td.

A.2. The Mode Price (Daily)

The mode price for an item $i \in I$ sold in a day td is defined by:

$$P_{i,td}^{Mode} = \text{mode}_{s \in S}(P_{i,td}^{s,Mode}),$$

where $P_{i,td}^{s,Mode}$ is the mode price for an item $i \in I$ sold at a store $s \in S$ in the day td. That is:

$$P_{i,td}^{s,Mode} = \text{mode}_{td \in tw}(P_{i,td}^{s,R}),$$

where tw is the week that includes the day td and $P_{i,td}^{s,R}$ is the value of $P_{i,td}^{s}$, which is rounded off to become an integer. If multiple modes exist, we select the highest value as the mode price.

A.3. The Bargain Sales

If $P_{i,td}^{s,Mode} - P_{i,td}^{s,R} > 2$, then we regard the commodity as being on sale. Note that we use the two-yen criterion to avoid identifying sales caused by rounding errors.

A.4. The Quantity-Weighted Average Price (Monthly)

The price of the weighted average by sales quantity for an item $i \in I$ in a month tm is defined by:

$$P_{i,tm}^{Weight} = \sum_{td \in tm} \frac{\sum_{s \in S} Q_{i,td}^{s}}{\sum_{td \in tm} \sum_{s \in S} Q_{i,td}^{s}} P_{i,td}^{Weight}.$$

It is the value of the monthly weighted average of $P_{i,td}^{Weight}$ by sales quantity.

A.5. The Mode Price (Monthly)

The mode price for item $i \in I$ in a month tm is defined by

$$P_{i,tm}^{Mode} = \sum_{td \in tm} \frac{\sum_{s \in S} Q_{i,td}^{s}}{\sum_{td \in tm} \sum_{s \in S} Q_{i,td}^{s}} P_{i,td}^{Mode}.$$

It is the value of the monthly weighted average of $P_{i,td}^{Mode}$ by sales quantity.

A.6. The Aggregate Price Change Rates by Chain Index Method

Suppose that $S_{i,tm}^{s}$ is the sales amount of item $i \in I$ in store $s \in S$ .The aggregate price change rate of item classification of C_j is defined by

$$\Pi^{N}_{C_j,tm} = \sum_{i \in C_j} \left[W_{i,tm-12} \times \left(\frac{P^{N}_{i,tm}}{P^{N}_{i,tm-12}} - 1 \right) \right],$$

where,

$W_{i,tm} = \frac{\sum_{s \in S} S^{s}_{i,tm}}{\sum_{i \in C_j} \sum_{s \in S} S^{s}_{i,tm}}$, N = weight or mode.

$\Pi^{Weight}_{C_j,tm}$ denotes the aggregate price change rate for the quantity weighted average, while $\Pi^{Mode}_{C_j,tm}$ denotes the aggregate price change rate for the mode prices.

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Table 1
Summary of Basic Information on Nikkei-POS

CY	Stores	Items	Sales(mil.;yen)	Sales/store(mil.;yen)	Observations
1988	29	88,248	24,969	861	25,399,307
1989	45	118,608	38,858	864	39,974,930
1990	50	131,412	47,951	959	46,470,061
1991	53	133,445	56,613	1,068	50,793,216
1992	62	136,179	67,407	1,087	56,118,695
1993	65	140,278	75,491	1,161	61,427,116
1994	103	157,457	115,864	1,125	91,735,608
1995	124	169,621	149,349	1,204	119,979,624
1996	132	177,344	180,689	1,369	150,404,905
1997	150	194,804	206,076	1,374	172,085,435
1998	172	219,063	262,931	1,529	218,527,524
1999	172	226,004	265,886	1,546	226,289,860
2000	189	251,052	276,477	1,463	242,357,354
2001	187	265,622	301,497	1,612	274,319,088
2002	198	276,496	314,058	1,586	283,433,270
2003	188	259,692	264,395	1,406	242,425,088
2004	202	279,751	306,378	1,517	282,074,725
2005	187	288,634	329,340	1,761	309,888,227
Sum			3,284,230	23,493	2,893,704,033

Note: The data does not cover November and December, 2003.

Table 2
Locational Distribution of Nikkei POS

Area	Retail Shops
Hokkaido	11
Tohoku	19
Kanto	90
Chubu	43
Kinki	57
Chugoku-Shikoku	24
Kyushu	36
Total	280

Table 3: Frequencies of Price Changes

item categories	frequencies of price changes (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	14.1	14.4	14.9	15.3	16.3	17.2	17.3	17.0	16.3	17.7	18.4	19.3	21.4	24.4	26.7	28.3	32.2	34.6
processed foods	15.1	15.3	15.9	16.4	17.5	18.4	18.4	18.1	17.2	18.3	19.1	20.1	22.3	25.2	27.4	28.9	32.5	35.0
chilled floor	20.1	20.1	20.9	22.0	23.5	25.6	25.0	24.7	23.1	24.2	25.6	26.4	28.4	31.1	32.7	34.5	37.5	39.7
tofu, natto and konnyaku	20.4	20.0	21.7	23.7	27.0	31.8	31.5	30.7	29.4	31.3	34.7	34.1	34.7	35.9	37.3	38.7	41.6	42.6
pickles and side dishes	17.0	18.7	20.4	23.7	26.5	28.8	27.6	27.1	23.9	24.0	25.5	27.4	29.7	33.1	35.4	37.8	41.2	44.2
pasted fish and chilled half-finished product	21.7	22.6	23.0	23.9	26.4	28.6	27.9	26.8	25.6	27.2	29.4	30.6	32.9	35.5	37.6	39.8	42.8	44.3
meat processed products	9.5	9.5	10.3	10.4	11.6	12.6	13.7	14.8	14.4	14.5	15.3	17.1	21.0	26.0	28.8	32.2	36.3	38.8
milk products and soy milks	28.5	27.5	28.2	29.0	29.3	31.1	30.4	30.4	27.1	28.7	30.3	31.0	32.4	34.1	34.3	35.8	38.6	40.9
chilled desert	18.3	18.2	17.7	20.7	23.5	24.7	21.0	19.9	20.9	24.1	28.0	29.8	35.1	39.9	41.8	42.9	45.2	46.1
beverage	9.9	10.1	11.1	12.0	12.2	12.4	12.5	12.5	13.1	13.6	12.7	13.5	16.4	19.7	21.8	22.8	26.0	28.4
room temperature floor	10.6	10.8	11.3	11.3	12.1	12.4	12.6	12.3	12.0	13.2	13.6	14.7	17.1	20.4	22.8	24.1	28.3	31.0
dried products and noodles	5.3	5.9	6.8	7.1	7.7	7.9	8.0	6.7	6.6	7.3	7.4	8.3	10.4	14.0	16.5	18.3	23.3	25.8
seasonings and sweetening	8.7	9.3	9.6	9.3	9.5	9.1	9.1	8.4	8.2	8.9	8.9	9.9	11.8	15.2	17.6	19.2	24.4	26.7
instant foods	7.9	8.0	8.9	8.7	9.1	8.8	9.1	8.5	8.6	9.3	9.7	10.9	12.9	16.1	18.4	19.5	23.8	26.3
canned products and bottled products	5.8	6.2	7.1	7.2	8.0	8.0	7.9	7.8	7.4	7.7	8.0	9.0	11.8	14.9	17.1	18.6	24.3	27.5
bread and mochi	30.1	27.0	27.1	27.2	30.7	33.5	33.3	33.7	31.8	33.8	36.0	38.5	41.7	44.2	45.6	47.7	49.8	52.4
jam, spread and premix	5.0	5.5	6.6	6.5	6.8	6.8	6.7	6.2	6.2	7.2	7.4	8.4	10.4	14.0	16.4	18.1	23.0	25.2
coffee and tea	11.0	10.3	9.8	9.4	9.8	9.9	9.9	8.5	8.6	9.2	9.5	10.5	12.6	16.5	19.5	20.5	26.1	29.2
sweets	7.8	8.6	10.0	10.5	11.1	10.6	10.5	9.8	9.7	11.0	11.4	12.3	14.3	17.5	19.8	21.2	25.8	27.7
alcoholic drinks	1.8	1.5	1.7	0.9	1.8	1.5	4.8	5.4	6.8	6.9	6.5	7.7	10.2	13.1	14.1	13.9	17.7	19.9
baby food, grains and others	21.0	18.3	13.9	13.7	16.5	19.3	19.3	20.7	19.7	22.2	22.4	22.9	26.3	30.7	33.6	34.9	38.2	41.9
frozen floor	15.7	15.7	16.0	17.1	16.9	15.9	16.4	17.3	20.2	21.3	22.7	24.6	26.9	29.5	32.8	35.1	37.6	39.2
frozen foods	15.2	15.5	15.8	17.0	17.4	16.5	16.9	17.4	20.5	21.9	23.4	25.7	27.9	30.5	34.0	36.3	39.1	40.5
ice cream and ice	16.9	16.1	16.5	17.5	15.6	14.2	15.0	17.2	19.4	19.7	20.3	21.3	23.8	26.1	29.3	32.0	33.8	35.6
domestic articles	5.4	7.2	7.5	7.8	9.0	9.4	9.6	9.7	10.4	13.2	13.0	14.1	15.5	18.4	22.3	24.1	29.2	31.3
consumable goods	5.4	7.3	7.5	7.9	9.0	9.4	9.6	9.7	10.4	13.2	13.0	14.1	15.5	18.4	22.3	24.1	29.2	31.3
bath and body care goods	5.8	6.3	7.3	7.7	9.5	10.8	11.2	11.7	11.2	13.3	13.3	14.6	15.3	18.6	23.6	25.8	30.3	32.1
oral care goods	4.1	5.1	5.8	6.1	7.6	8.3	8.7	9.1	8.9	10.8	10.9	12.4	13.7	17.0	21.6	23.4	27.6	28.7
sanitary goods	9.6	12.3	12.1	12.9	12.9	12.6	13.2	13.0	13.0	15.9	15.8	17.1	18.6	22.2	26.4	29.9	33.5	35.6
detergent	8.7	10.2	9.6	10.3	11.2	11.1	11.2	10.5	10.7	12.9	12.9	13.8	15.3	18.7	23.0	24.8	29.7	31.6
living environmental goods	5.1	5.4	5.7	6.7	8.5	9.3	9.9	9.2	9.5	12.1	11.6	13.5	14.7	19.4	23.7	26.2	30.7	31.9
cosmetic goods	2.2	4.7	4.1	4.2	6.7	6.8	8.3	10.7	20.0	30.9	29.9	30.1	30.5	33.5	36.3	36.9	39.9	44.4
hair cosmetic	1.4	3.1	3.4	3.5	6.7	9.0	10.3	11.7	11.6	15.7	16.7	17.3	18.9	22.6	27.5	30.2	34.8	36.4
fragrance	0.5	0.9	3.4	3.5	5.0	6.9	7.6	9.8	16.3	26.5	34.2	33.2	34.1	36.2	40.1	45.7	37.0	32.6
appearance goods	1.5	2.7	3.5	4.3	6.5	8.1	8.6	8.9	9.7	12.8	13.1	14.7	16.8	20.5	24.5	27.8	30.0	31.7
medical related goods and sundry goods	1.6	2.6	3.0	2.4	3.1	3.7	4.3	4.6	4.6	5.6	5.6	5.7	6.1	7.2	9.0	9.0	18.5	22.8
kitchen consumable goods	3.2	5.5	5.8	6.0	8.2	9.2	9.4	8.9	8.8	10.4	10.6	12.1	13.7	16.5	19.9	21.4	25.8	26.5
stationary	0.6	1.3	1.6	3.3	4.8	6.9	7.3	7.1	7.2	9.3	9.1	11.0	13.3	15.2	19.7	20.7	23.5	25.9
pet food and pet sanitary	3.2	4.5	5.6	6.3	8.2	9.5	9.6	12.0	11.1	12.7	13.5	15.0	16.8	19.5	23.5	24.8	32.0	35.2
gifts	NaN	0.0	0.0	0.0	0.0	14.6	14.7	6.6	9.7	9.2	8.4	14.8	17.2	22.4	31.0	30.0	32.2	33.8
durable goods	0.8	2.6	3.0	4.1	5.6	8.5	9.6	9.3	10.2	13.4	12.4	15.5	16.5	18.5	23.8	25.2	29.6	32.9
wash bowl, bath, kitchen and laundry goods	0.8	2.7	3.8	4.9	6.3	9.3	9.6	9.2	10.0	12.9	12.0	14.8	15.7	17.8	22.6	24.3	29.1	32.6
dishes	0.0	0.0	0.0	0.0	14.6	13.5	11.8	10.7	13.1	18.2	17.0	21.6	22.5	23.9	31.8	33.1	36.1	40.2
car goods	NaN	2.6	0.9	1.2	1.1	0.6	0.5	3.0	2.0	14.3	11.5	12.7	11.5	18.6	25.4	22.3	23.8	62.7

Notes: All frequencies are reported in percent per day. The frequencies are calculated by: (i) rounding prices off below the decimal point to remove the effects of time sales within each day, (ii) taking the means of dummy variables that take a value of unity when the price is different from the day before, (iii) calculating the item category level frequencies using the weighted average of item level frequencies with sales weights, and (iv) calculating the total level frequencies by weighted average of item category level frequencies by sales weights. Note that we remove samples that are not sold over 300 days per store when we calculate the frequencies.

Table 4: Frequencies of Regular Price Changes

item categories	frequencies of regular price changes (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	2.7	2.5	2.6	2.7	2.9	2.7	2.6	2.6	2.8	3.1	3.3	3.3	3.4	3.8	4.1	4.0	4.5	4.2
processed foods	2.8	2.5	2.7	2.7	2.9	2.7	2.5	2.5	2.7	2.9	3.1	3.1	3.2	3.6	3.8	3.7	4.2	4.0
chilled floor	3.1	2.7	2.9	3.1	3.3	3.1	2.9	2.9	3.0	3.2	3.3	3.3	3.4	3.7	3.9	3.9	4.2	3.8
tofu, natto and konnyaku	2.8	2.2	2.7	3.0	3.2	3.3	3.1	3.2	3.3	3.7	3.9	3.7	3.7	3.7	3.9	3.9	4.1	3.7
pickles and side dishes	2.3	2.1	2.2	2.5	2.9	3.1	3.0	2.8	2.8	2.9	3.1	3.2	3.3	3.6	4.0	4.1	4.3	4.1
pasted fish and chilled half-finished product	3.2	2.8	3.2	3.6	3.7	3.4	3.0	2.9	3.1	3.4	3.5	3.5	3.6	3.9	4.3	4.5	4.8	4.4
meat processed products	2.1	1.8	2.0	1.6	1.9	1.9	1.9	1.9	2.2	2.3	2.5	2.5	2.8	3.3	3.6	3.8	4.5	4.0
milk products and soy milks	3.8	3.3	3.6	3.8	3.9	3.7	3.3	3.5	3.4	3.6	3.7	3.7	3.6	3.8	3.8	3.8	4.0	3.7
chilled desert	3.3	3.0	3.3	3.6	3.7	3.5	3.1	3.1	3.3	3.7	4.1	3.9	4.1	4.5	4.7	4.7	4.8	4.5
beverage	3.0	2.8	2.9	3.0	3.2	2.6	2.3	2.3	2.7	2.9	2.8	2.8	3.0	3.4	3.6	3.3	3.5	3.2
room temperature floor	2.5	2.3	2.4	2.3	2.5	2.3	2.2	2.2	2.3	2.6	2.8	2.8	3.0	3.5	3.7	3.5	4.2	4.0
dried products and noodles	1.9	1.8	2.0	2.0	2.0	1.8	1.7	1.6	1.8	1.8	2.0	2.1	2.3	2.6	2.7	2.3	3.3	3.1
seasonings and sweetening	2.8	2.8	2.8	2.6	2.7	2.2	2.0	2.1	2.2	2.3	2.5	2.5	2.6	2.9	3.2	2.9	3.7	3.5
instant foods	2.5	2.4	2.6	2.5	2.5	2.3	2.2	2.2	2.3	2.4	2.7	2.7	2.9	3.4	3.7	3.4	4.0	3.8
canned products and bottled products	2.2	2.0	2.1	2.0	2.1	2.1	1.7	2.2	2.4	2.2	2.5	2.4	2.8	3.2	3.4	3.1	4.0	3.6
bread and mochi	2.1	1.8	1.9	1.9	2.5	2.7	2.4	2.5	2.4	2.6	2.8	2.8	3.1	3.6	3.9	4.0	4.4	4.4
jam, spread and premix	2.0	1.9	2.2	2.1	2.0	1.8	1.5	1.6	1.8	2.0	2.3	2.4	2.7	3.1	3.3	2.8	4.0	3.9
coffee and tea	3.9	3.6	3.1	3.1	2.9	2.7	2.5	2.3	2.5	2.7	2.9	2.9	3.1	3.6	4.0	3.4	4.6	4.5
sweets	2.0	2.0	2.1	2.3	2.5	2.2	2.0	1.9	2.0	2.2	2.3	2.4	2.5	2.8	2.9	2.7	3.4	3.2
alcoholic drinks	0.6	0.6	0.4	0.3	0.5	0.5	1.4	1.3	1.5	1.8	1.9	2.2	2.4	3.0	3.4	3.2	3.6	3.5
baby food, grains and others	3.1	3.1	2.8	2.5	2.9	3.1	4.0	3.4	4.1	4.7	4.8	4.8	5.2	5.6	5.6	5.5	6.5	6.1
frozen floor	4.0	3.5	3.4	3.6	3.8	3.4	3.0	3.1	3.8	3.9	4.0	4.0	3.8	4.1	4.7	4.7	5.0	4.6
frozen foods	3.5	3.1	3.2	3.4	3.9	3.5	3.1	3.1	3.8	4.1	4.2	4.1	3.9	4.2	4.8	4.8	5.3	4.8
ice cream and ice	5.1	4.6	4.1	4.1	3.7	3.3	2.7	3.2	3.6	3.3	3.4	3.5	3.6	3.9	4.5	4.5	4.5	4.3
domestic articles	2.0	2.1	2.2	2.4	2.8	2.7	2.7	2.8	3.1	4.3	4.5	4.9	5.1	5.3	6.0	5.9	6.9	6.5
consumable goods	2.0	2.1	2.2	2.4	2.8	2.7	2.7	2.8	3.1	4.3	4.5	4.9	5.0	5.2	6.0	5.8	6.9	6.5
bath and body care goods	2.8	2.3	2.6	2.8	3.6	3.9	4.0	4.2	4.3	5.2	5.5	5.8	5.6	5.6	6.3	5.6	6.6	5.9
oral care goods	1.7	1.5	1.6	1.7	2.2	2.2	2.3	2.6	2.7	3.8	3.8	4.3	4.4	4.6	5.5	5.2	6.3	5.7
sanitary goods	3.3	3.4	3.5	3.8	3.8	3.6	3.7	3.9	4.1	4.9	5.0	4.9	4.8	5.3	5.5	4.9	5.8	4.9
detergent	3.0	3.1	3.0	3.2	3.5	3.1	2.9	2.7	3.1	3.7	3.7	3.6	3.7	3.9	4.7	4.5	5.3	4.6
living environmental goods	2.7	2.2	2.1	2.7	3.3	3.3	3.3	3.1	3.5	4.7	4.6	5.0	5.1	5.9	7.0	6.6	8.0	7.2
cosmetic goods	0.6	1.1	0.9	1.1	2.4	2.5	2.7	2.5	4.8	10.0	11.7	14.2	14.1	13.8	14.2	13.6	13.8	15.3
hair cosmetic	1.0	1.7	1.3	1.2	2.5	3.5	4.4	4.8	5.3	7.6	8.7	9.7	10.3	10.8	12.1	12.0	14.6	14.4
fragrance	0.0	0.9	1.4	1.6	2.8	2.8	4.1	5.4	10.5	17.6	22.0	23.4	21.3	21.5	22.1	22.0	20.0	13.3
appearance goods	0.6	0.6	0.7	1.0	1.9	2.4	2.6	2.7	3.0	4.7	5.3	6.1	6.9	7.2	8.0	8.0	9.2	8.8
medical related goods and sundry goods	0.3	0.4	0.6	0.5	0.5	0.6	0.7	0.8	0.8	1.5	1.7	1.6	1.6	1.6	2.0	2.3	4.0	4.2
kitchen consumable goods	0.9	1.2	1.3	1.5	2.2	2.0	2.0	1.9	2.0	2.7	2.8	2.9	3.1	2.8	3.7	3.7	4.3	3.3
stationary	0.3	0.5	0.5	1.5	2.3	2.8	2.2	1.8	1.9	2.8	3.2	3.9	4.7	4.4	5.5	5.6	6.4	6.7
pet food and pet sanitary	2.0	2.0	2.5	2.3	2.9	3.2	2.9	3.6	3.3	4.1	4.6	5.3	5.9	6.1	7.2	7.0	8.8	9.1
gifts	NaN	0.0	0.0	0.0	0.0	4.6	8.4	2.8	4.3	3.6	3.0	5.9	6.1	8.3	9.7	10.6	11.9	12.7
durable goods	0.2	1.0	1.2	1.8	1.9	3.5	3.2	2.4	2.9	4.1	4.9	7.0	7.6	7.6	8.8	9.5	11.6	11.8
wash bowl, bath, kitchen and laundry goods	0.2	1.0	1.4	2.0	2.1	3.7	3.0	2.2	2.6	3.6	4.6	6.6	7.0	7.1	8.3	8.9	11.3	11.5
dishes	0.0	0.0	0.0	0.0	7.7	7.1	7.2	5.6	5.5	9.5	9.8	12.0	11.8	11.5	12.3	13.7	15.3	17.0
car goods	NaN	1.0	0.6	1.1	0.8	0.4	0.4	2.6	1.6	1.6	3.0	4.3	4.9	4.8	7.6	8.0	13.8	62.7

Notes: All frequencies are reported in percent per day. The frequencies are calculated by: (i) rounding prices off below the decimal point to remove the effects of time sales within each day, (ii) taking weekly mode of price for the item in the store, (iii) taking the means of dummy variables that take a value of unity when the price is different from the day before, (iv) calculating the item category level frequencies using the weighted average of item level frequencies with sales weights, and (v) calculating the total level frequencies by weighted average of item category level frequencies by sales weights. Note that we remove samples that are not sold over 300 days per store when we calculate the frequencies.

Table 5: Monthly Frequencies of Regular Price Changes

item categories	monthly frequencies of regular price changes (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	18.9	21.2	25.1	26.0	26.1	26.0	24.5	24.7	25.0	26.1	27.3	27.3	28.5	29.1	31.0	28.7	35.6	28.9
processed foods	19.8	22.3	26.5	27.9	27.7	27.0	25.7	25.8	25.9	26.7	27.8	27.9	29.3	30.4	32.3	29.6	36.3	29.6
chilled floor	18.3	21.2	26.3	27.6	27.8	28.4	26.7	26.8	27.2	27.2	29.9	30.1	30.5	31.2	32.3	31.5	37.1	31.2
tofu, natto and konnyaku	20.5	17.6	23.1	24.3	27.1	30.9	32.2	33.3	28.4	30.0	36.1	35.3	34.1	34.3	32.4	32.4	37.0	32.0
pickles and side dishes	17.2	17.8	19.6	23.2	24.9	27.0	26.7	24.4	24.4	23.2	26.9	27.5	28.5	29.2	31.6	30.9	34.8	29.2
pasted fish and chilled half-finished product	16.7	18.4	23.7	27.6	26.1	26.0	22.9	24.0	23.7	25.0	26.7	25.7	26.8	28.7	30.7	29.5	37.2	31.2
meat processed products	14.8	15.0	25.5	16.8	18.1	15.6	16.8	17.7	19.2	17.6	23.1	23.6	24.0	27.1	31.4	33.1	39.7	30.8
milk products and soy milks	19.5	27.8	34.1	38.8	34.1	37.6	35.7	35.2	36.2	34.3	32.6	36.4	35.1	32.9	32.4	32.6	40.0	34.2
chilled desert	22.5	22.7	28.0	26.6	30.5	32.9	28.0	33.0	30.9	36.2	37.9	37.4	40.5	41.7	42.3	41.0	43.4	41.5
beverage	22.2	26.8	26.4	27.2	34.0	28.3	21.9	20.1	24.6	25.7	31.5	27.7	30.2	32.2	33.2	29.0	32.5	26.6
room temperature floor	20.8	22.8	26.6	28.1	27.0	24.9	24.2	24.9	24.7	26.2	25.9	26.0	28.0	29.5	31.8	28.1	35.6	28.6
dried products and noodles	18.4	19.2	25.4	26.5	26.0	20.9	20.2	22.8	22.2	22.2	24.7	24.9	27.0	26.8	29.1	21.5	34.0	25.5
seasonings and sweetening	26.4	30.3	35.0	33.9	34.0	27.8	28.8	31.8	27.7	28.4	25.3	21.7	25.2	27.2	30.3	26.5	35.9	28.0
instant foods	28.4	30.2	37.8	38.1	33.0	30.7	29.9	27.9	29.3	29.5	27.8	28.3	31.9	35.3	39.3	35.8	41.6	33.0
canned products and bottled products	18.1	18.1	22.8	27.2	20.1	22.6	18.5	21.7	23.6	21.5	21.5	23.9	26.0	29.0	30.7	25.2	33.6	26.5
bread and mochi	11.1	10.3	16.4	18.2	17.5	22.0	19.3	19.9	18.7	19.9	22.4	21.2	24.1	27.5	30.0	31.0	34.5	31.6
jam, spread and premix	12.6	22.3	21.0	25.7	23.7	19.1	17.6	19.3	21.5	21.0	19.0	17.9	19.3	24.4	25.9	21.5	30.6	25.5
coffee and tea	31.4	32.1	29.9	37.2	32.3	24.8	20.1	23.5	27.8	29.1	24.7	24.0	29.9	32.9	33.8	29.0	38.0	31.8
sweets	16.4	19.6	21.2	24.4	26.9	25.4	22.1	21.9	21.2	22.3	25.6	24.8	25.6	24.8	27.4	22.4	29.0	25.4
alcoholic drinks	2.7	6.4	7.1	2.6	3.1	3.1	20.8	22.6	22.2	23.7	20.3	24.1	22.1	21.3	26.0	21.5	24.4	15.7
baby food, grains and others	10.7	16.0	24.3	22.5	23.0	27.3	31.3	27.9	29.2	35.1	34.1	36.8	38.1	40.4	39.4	37.7	48.6	39.7
frozen floor	22.6	25.9	27.6	27.8	33.2	34.5	30.7	27.4	26.8	28.4	31.6	31.5	33.9	33.2	36.2	32.2	37.1	29.7
frozen foods	23.9	25.2	28.6	30.4	36.8	39.2	34.5	29.6	29.1	30.8	33.8	34.2	36.5	34.6	38.1	33.4	36.7	31.1
ice cream and ice	20.1	27.3	25.4	22.7	25.5	23.4	22.1	21.8	20.6	22.3	25.6	23.8	26.7	29.0	31.1	29.0	38.1	26.2
domestic articles	11.9	14.2	16.4	15.9	17.7	21.0	18.6	19.4	20.9	23.5	25.0	24.4	24.6	23.3	25.7	24.7	32.6	26.0
consumable goods	12.1	14.5	16.7	16.1	17.9	21.3	18.9	19.7	21.3	24.0	25.5	24.8	25.0	23.5	25.9	25.0	32.9	26.0
bath and body care goods	15.0	17.4	17.8	14.7	20.2	29.1	30.6	30.2	35.0	29.6	31.2	32.6	29.2	31.7	32.4	28.0	32.8	25.6
oral care goods	14.8	15.0	18.5	19.7	15.8	22.5	20.4	27.0	29.2	29.0	33.2	32.8	32.2	29.6	26.4	23.0	33.3	23.5
sanitary goods	16.3	18.8	25.5	21.1	28.7	31.6	26.2	30.9	35.4	30.8	37.1	31.3	31.1	38.3	38.2	30.3	38.1	29.4
detergent	24.8	27.3	29.9	29.2	27.3	33.6	32.3	30.4	36.3	42.9	40.9	33.9	33.2	35.9	45.4	41.5	51.4	40.6
living environmental goods	16.0	17.8	17.8	19.7	25.0	27.0	27.7	27.3	25.8	31.9	31.2	31.1	28.1	32.5	33.3	31.1	42.7	30.1
cosmetic goods	0.0	5.3	4.2	1.6	1.6	3.5	3.9	5.2	10.0	21.1	20.6	20.6	24.7	14.7	19.8	21.5	28.1	24.2
hair cosmetic	0.7	8.1	1.7	1.3	4.6	13.1	17.5	23.7	21.0	22.3	21.7	21.6	28.9	24.0	25.2	23.6	31.4	27.2
fragrance	0.0	7.5	3.6	0.0	0.0	0.0	0.2	2.6	3.7	1.7	1.2	5.3	4.1	0.9	5.0	9.4	8.5	8.7
appearance goods	0.5	1.6	2.4	7.9	6.2	17.9	14.8	12.9	15.2	16.5	22.3	22.3	22.7	23.2	23.2	25.8	35.3	28.0
medical related goods and sundry goods	0.9	2.9	3.2	5.0	4.8	5.5	4.3	10.3	7.0	11.5	13.7	14.4	10.0	11.1	13.4	17.2	26.7	16.8
kitchen consumable goods	6.0	7.4	11.1	14.5	17.1	14.9	15.0	15.9	16.1	17.8	20.3	23.7	23.9	23.1	26.1	25.5	33.6	23.7
stationary	1.1	4.1	3.0	6.8	4.3	3.5	4.1	7.2	6.4	4.9	6.0	6.6	6.8	7.1	8.3	8.8	11.2	9.7
pet food and pet sanitary	11.6	13.2	16.6	19.5	17.9	25.2	20.5	23.5	19.9	25.5	27.5	26.3	23.9	25.9	27.8	27.7	35.8	31.3
gifts	0.0	0.0	7.5	0.6	8.6	19.9	11.6	5.1	7.6	9.2	9.7	36.7	46.7	28.8	29.1	33.7	52.6	57.5
durable goods	0.5	1.0	2.9	5.5	5.4	6.6	5.2	8.0	5.1	6.8	6.9	8.0	11.4	14.9	15.7	13.3	22.1	24.4
wash bowl, bath, kitchen and laundry goods	0.5	1.1	1.3	4.4	5.3	7.4	4.5	6.6	5.2	6.6	5.7	6.5	10.3	14.2	12.7	13.3	19.9	21.1
dishes	NaN	NaN	6.5	0.6	0.0	2.3	7.4	13.1	5.0	7.6	9.5	10.4	12.9	15.8	18.8	13.4	24.0	26.7
car goods	NaN	NaN	13.7	20.0	16.9	9.8	0.0	5.5	0.2	4.4	11.5	19.9	8.1	10.5	33.5	0.0	0.0	4.5

Notes: All frequencies are reported in percent per month. Notes: All frequencies are reported in percent per day. The frequencies are calculated by: (i) rounding prices off below the decimal point to remove the effects of time sales within each day, (ii) taking weekly mode of price for the item in the store, (iii) picking up the samples by the condition that they are prices on Wednesday in the week containing 15th day of the month, (iv) taking the means of dummy variables that take a value of unity when the price is different from the day before, (v) calculating the item category level frequencies using the weighted average of item level frequencies with sales weights, and (vi) calculating the total level frequencies by weighted average of item category level frequencies by sales weights. Note that we remove samples that are not sold over 300 days per store when we calculate the frequencies.

Table 6: Frequencies of Bargain Sales

item categories	frequencies of bargain sales (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	7.6	8.1	8.0	7.9	8.5	9.8	10.0	9.8	9.0	9.6	10.3	11.2	12.2	12.9	13.5	14.1	15.0	16.5
processed foods	8.1	8.6	8.6	8.6	9.2	10.5	10.7	10.5	9.6	10.1	10.9	11.9	12.8	13.5	14.0	14.6	15.4	17.0
chilled floor	10.9	11.6	11.6	11.7	12.6	14.8	14.7	14.3	12.9	13.4	14.5	15.6	16.3	16.6	16.7	17.3	18.3	20.0
tofu, natto and konnyaku	10.8	11.3	11.6	11.7	13.4	17.2	17.9	17.1	15.9	17.1	19.4	19.5	19.2	18.7	18.7	18.9	20.2	21.2
pickles and side dishes	9.6	11.4	12.0	13.9	15.7	17.7	17.2	16.8	14.4	14.1	15.3	17.1	18.2	19.3	19.7	20.9	22.2	24.5
pasted fish and chilled half-finished product	11.7	13.4	13.2	12.8	14.4	16.8	17.0	16.2	14.9	15.5	17.1	18.4	19.5	20.0	20.2	21.0	22.3	23.7
meat processed products	4.7	4.9	5.3	5.0	5.8	7.4	8.2	8.6	8.1	8.1	8.7	10.6	12.3	13.8	14.7	16.5	17.7	20.1
milk products and soy milks	15.8	15.7	15.5	15.7	15.7	18.0	17.6	17.5	15.1	15.6	16.7	17.8	18.2	18.1	17.2	17.4	18.6	20.5
chilled desert	9.8	10.6	9.7	11.0	12.9	14.3	12.6	11.7	11.9	13.6	16.6	18.1	21.2	23.0	23.4	23.6	24.1	25.2
beverage	4.9	5.4	5.4	5.6	5.8	6.5	6.5	6.3	6.2	6.3	6.3	7.4	8.4	8.9	9.4	9.6	10.1	11.6
room temperature floor	5.6	5.8	5.9	5.8	6.2	6.9	7.1	7.1	6.6	7.3	7.7	8.6	9.7	10.9	11.7	12.3	13.0	14.4
dried products and noodles	2.6	2.9	3.4	3.3	3.8	4.5	4.4	3.7	3.4	4.0	4.2	5.0	5.6	6.9	7.7	8.5	9.7	10.8
seasonings and sweetening	4.6	5.0	5.1	4.7	4.7	5.2	5.2	4.9	4.4	4.9	5.1	6.0	6.6	7.7	8.6	9.3	10.6	11.9
instant foods	4.1	4.3	4.5	4.3	4.5	4.8	5.0	4.6	4.4	4.8	5.4	6.4	7.2	8.0	8.7	9.0	10.0	11.3
canned products and bottled products	2.8	3.3	3.5	3.4	3.9	4.5	4.6	4.3	3.5	3.9	4.3	5.5	6.6	7.1	7.9	8.6	9.8	11.5
bread and mochi	16.2	14.9	14.9	14.7	16.4	18.6	19.2	19.7	18.4	19.6	21.1	22.8	24.6	25.5	25.8	26.6	27.0	29.3
jam, spread and premix	2.3	2.7	3.0	3.0	3.2	3.6	3.5	3.2	3.0	3.7	3.9	4.6	5.4	6.6	7.5	8.6	9.6	10.3
coffee and tea	5.8	5.4	4.9	4.4	4.8	5.4	5.5	4.8	4.5	4.9	5.2	6.0	7.0	8.5	9.8	10.5	11.4	12.5
sweets	4.0	4.5	5.0	5.1	5.5	5.8	5.7	5.2	4.9	5.7	6.2	6.8	7.6	8.6	9.4	9.8	10.7	11.5
alcoholic drinks	0.6	0.7	0.6	0.3	0.6	0.6	2.0	2.7	3.1	3.5	3.4	4.5	6.0	6.8	6.9	6.6	7.0	7.6
baby food, grains and others	15.2	11.2	6.9	8.0	9.2	11.5	11.7	13.4	12.0	12.8	13.3	13.7	15.6	17.6	18.8	19.8	19.4	21.1
frozen floor	8.1	9.3	9.1	8.9	8.5	9.5	10.7	10.8	11.7	12.0	13.3	15.2	16.5	16.6	17.0	17.8	18.2	19.4
frozen foods	8.1	9.5	9.3	8.9	8.6	10.1	11.5	11.3	12.3	12.7	14.3	16.4	17.8	17.7	18.2	19.0	19.4	20.6
ice cream and ice	8.1	8.6	8.6	8.9	8.1	7.8	8.4	9.3	9.9	9.9	10.4	11.4	12.4	13.0	13.6	14.6	15.1	16.3
domestic articles	2.6	3.7	3.5	3.5	4.0	4.8	5.1	5.3	5.2	5.8	5.8	6.7	7.7	8.6	9.8	10.8	11.8	12.6
consumable goods	2.6	3.7	3.5	3.5	4.0	4.8	5.1	5.3	5.2	5.9	5.9	6.7	7.7	8.7	9.8	10.8	11.8	12.6
bath and body care goods	2.4	3.1	3.3	3.2	4.0	5.2	5.7	6.0	5.3	5.7	5.7	6.8	7.5	9.0	11.0	12.5	13.6	14.7
oral care goods	1.8	2.5	2.6	2.5	3.3	4.4	4.5	4.9	4.6	4.8	5.1	6.1	7.1	8.2	9.6	10.6	11.7	12.3
sanitary goods	4.8	6.4	5.8	6.0	5.9	6.8	7.6	7.6	7.0	7.9	8.0	9.5	10.8	11.8	13.3	15.5	15.8	16.9
detergent	4.3	5.7	4.9	5.0	5.3	6.1	6.6	6.5	6.0	6.6	7.0	8.2	9.2	10.0	11.3	12.1	13.3	14.4
living environmental goods	2.3	2.6	2.4	2.6	3.5	4.6	5.0	4.9	4.4	5.0	5.0	6.5	7.7	9.4	10.5	12.1	12.7	13.6
cosmetic goods	1.0	2.1	1.7	1.7	2.5	2.7	3.4	5.0	8.8	11.5	10.2	9.7	10.9	12.3	12.7	13.2	15.1	17.7
hair cosmetic	0.4	1.0	1.3	1.3	2.5	3.5	4.0	4.9	4.4	5.2	5.4	5.4	6.5	8.1	9.9	11.7	11.8	12.7
fragrance	0.2	0.0	1.0	1.0	1.2	2.0	2.2	2.5	3.4	6.2	7.9	6.8	8.3	10.0	12.0	16.0	11.1	12.0
appearance goods	0.6	1.2	1.5	1.7	2.6	3.6	3.7	4.3	4.4	5.0	5.0	5.6	6.8	8.5	9.8	11.8	11.5	12.4
medical related goods and sundry goods	0.6	1.3	1.4	1.0	1.4	1.8	2.1	2.5	2.4	2.6	2.5	2.7	2.9	3.3	3.9	3.7	4.4	4.6
kitchen consumable goods	1.5	2.5	2.5	2.8	3.8	5.3	5.1	5.2	4.8	4.9	5.4	6.7	7.6	8.3	9.1	9.5	10.7	11.2
stationary	0.3	0.5	0.6	1.2	1.6	2.8	3.0	3.2	3.1	3.7	3.6	4.5	5.6	6.3	8.0	8.6	8.9	9.7
pet food and pet sanitary	1.2	1.8	2.2	2.5	3.4	4.4	4.6	6.3	5.4	5.9	6.3	7.0	8.1	9.0	10.2	11.0	13.0	14.4
gifts	NaN	0.0	0.0	0.0	0.0	6.5	5.3	2.5	3.1	3.4	3.4	6.0	7.6	8.5	11.7	11.4	11.0	11.6
durable goods	0.3	1.1	1.1	1.4	2.2	3.2	4.2	4.3	4.6	5.6	4.9	5.6	6.4	7.2	9.2	9.9	10.6	12.4
wash bowl, bath, kitchen and laundry goods	0.3	1.1	1.4	1.7	2.4	3.6	4.3	4.3	4.5	5.5	4.8	5.4	6.1	7.0	8.7	9.6	10.4	12.4
dishes	0.0	0.0	0.0	0.0	3.7	4.2	2.9	4.0	5.0	5.6	4.5	6.4	8.4	8.7	12.2	12.2	13.4	14.1
car goods	NaN	2.1	0.3	0.5	0.7	0.4	0.1	0.3	0.4	8.6	6.2	5.8	4.7	8.4	10.5	7.8	5.0	0.0

Notes: All frequencies are reported in percent per day. Notes: All frequencies are reported in percent per day. The frequencies are calculated by: (i) taking the means of dummy variables that take a value of unity when the value of the regular price minus the raw price is lager than 2 , (ii) calculating the item category level frequencies using the weighted average of item level frequencies with sales weights, and (iii) calculating the total level frequencies by weighted average of item category level frequencies by sales weights. Note that we remove samples that are not sold over 300 days per store when we calculate the frequencies.

Table 7: Cross Correlations between GDP Gap and Inflation Rates

	SD(%)	cross correlations between GDP gap and inflation rates with lag t																
		-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
GDP gap	1.25	-0.38	-0.26	-0.04	0.10	0.24	0.47	0.61	0.79	1.00	0.79	0.61	0.47	0.24	0.10	-0.04	-0.26	-0.39
CPI(total)	1.21	-0.08	-0.02	0.05	0.11	0.18	0.25	0.32	0.34	0.40	0.44	0.46	0.44	0.43	0.39	0.36	0.37	0.37
CPI(excl. fresh foods)	1.12	-0.11	-0.05	0.01	0.08	0.16	0.25	0.31	0.35	0.38	0.40	0.43	0.41	0.42	0.41	0.38	0.39	0.39
CPI(excl. foods and energy)	1.15	-0.04	0.01	0.05	0.10	0.16	0.24	0.27	0.28	0.31	0.31	0.34	0.36	0.37	0.39	0.39	0.39	0.40
CPI(processed foods & domestic articles)	1.23	-0.34	-0.27	-0.21	-0.14	-0.07	0.00	0.10	0.23	0.32	0.36	0.39	0.38	0.40	0.45	0.47	0.48	0.47
CPI(processed foods)	1.32	-0.31	-0.24	-0.18	-0.11	-0.04	0.02	0.11	0.24	0.33	0.38	0.40	0.38	0.40	0.45	0.47	0.49	0.48
CPI(processed foods (excl. cereals))	1.21	-0.31	-0.22	-0.15	-0.07	0.01	0.09	0.19	0.31	0.40	0.46	0.50	0.50	0.50	0.49	0.46	0.46	0.45
CPI(domestic articles)	0.91	-0.27	-0.26	-0.23	-0.21	-0.15	-0.08	-0.02	0.04	0.08	0.07	0.12	0.16	0.18	0.22	0.22	0.20	0.21
POS(processed foods & domestic articles)	1.50	-0.17	-0.05	0.05	0.14	0.20	0.27	0.35	0.43	0.51	0.56	0.54	0.50	0.43	0.36	0.31	0.27	0.22
POS(processed foods)	1.59	-0.16	-0.04	0.05	0.13	0.19	0.26	0.34	0.43	0.51	0.56	0.54	0.49	0.42	0.35	0.29	0.26	0.21
POS(processed foods (excl. cereals))	1.58	-0.17	-0.05	0.05	0.14	0.21	0.28	0.37	0.45	0.52	0.58	0.57	0.53	0.45	0.36	0.29	0.24	0.19
POS(domestic articles)	1.09	-0.12	-0.08	-0.04	-0.01	0.02	0.03	0.05	0.06	0.07	0.10	0.12	0.13	0.11	0.13	0.11	0.08	0.08
t-stats of Cross Correlations																		
GDP gap		-3.20	-2.11	-0.28	0.78	1.98	4.23	6.25	10.38	Inf	10.38	6.25	4.23	1.98	0.78	-0.28	-2.11	-3.20
CPI(total)		-0.64	-0.15	0.44	0.90	1.56	2.30	2.93	3.23	3.88	4.31	4.47	4.26	4.09	3.58	3.16	3.20	3.15
CPI(excl. fresh foods)		-0.99	-0.46	0.07	0.70	1.46	2.28	2.89	3.37	3.74	3.97	4.20	3.99	3.94	3.77	3.45	3.47	3.41
CPI(excl. foods and energy)		-0.37	0.06	0.45	0.90	1.49	2.24	2.51	2.65	2.92	2.87	3.25	3.39	3.41	3.57	3.56	3.46	3.50
CPI(processed foods & domestic articles)		-2.76	-2.21	-1.68	-1.11	-0.58	-0.01	0.78	1.87	2.74	3.16	3.42	3.29	3.46	3.94	4.12	4.24	4.05
CPI(processed foods)		-2.56	-1.96	-1.43	-0.86	-0.36	0.13	0.91	2.01	2.90	3.39	3.57	3.34	3.50	3.96	4.17	4.37	4.18
CPI(processed foods (excl. cereals))		-2.58	-1.83	-1.19	-0.58	0.10	0.77	1.62	2.69	3.57	4.27	4.77	4.73	4.63	4.47	4.13	4.03	3.87
CPI(domestic articles)		-2.67	-2.66	-2.37	-2.09	-1.56	-0.78	-0.23	0.43	0.83	0.77	1.26	1.67	1.86	2.26	2.22	2.02	2.03
POS(processed foods & domestic articles)		-1.37	-0.43	0.39	1.08	1.63	2.20	2.98	3.90	4.80	5.45	5.22	4.59	3.72	3.02	2.50	2.13	1.75
POS(processed foods)		-1.29	-0.36	0.42	1.09	1.61	2.21	3.04	4.03	5.02	5.65	5.36	4.63	3.75	2.96	2.44	2.10	1.68
POS(processed foods (excl. cereals))		-1.34	-0.41	0.39	1.13	1.73	2.41	3.30	4.26	5.18	5.94	5.77	5.12	4.14	3.10	2.37	1.94	1.53
POS(domestic articles)		-1.38	-1.01	-0.50	-0.15	0.26	0.35	0.57	0.80	0.87	1.29	1.45	1.59	1.32	1.53	1.33	0.96	0.92
P-value of t-stats																		
GDP gap		0.00	0.04	0.78	0.44	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.44	0.78	0.04	0.00
CPI(total)		0.53	0.89	0.66	0.37	0.12	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CPI(excl. fresh foods)		0.33	0.65	0.94	0.49	0.15	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CPI(excl. foods and energy)		0.71	0.95	0.66	0.37	0.14	0.03	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CPI(processed foods & domestic articles)		0.01	0.03	0.10	0.27	0.57	1.00	0.44	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CPI(processed foods)		0.01	0.05	0.16	0.40	0.72	0.89	0.37	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CPI(processed foods (excl. cereals))		0.01	0.07	0.24	0.57	0.92	0.45	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CPI(domestic articles)		0.01	0.01	0.02	0.04	0.12	0.44	0.82	0.67	0.41	0.44	0.21	0.10	0.07	0.03	0.03	0.05	0.05
POS(processed foods & domestic articles)		0.18	0.67	0.70	0.29	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.09
POS(processed foods)		0.20	0.72	0.68	0.28	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.10
POS(processed foods (excl. cereals))		0.19	0.68	0.69	0.26	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.13
POS(domestic articles)		0.17	0.32	0.62	0.88	0.80	0.73	0.57	0.43	0.39	0.20	0.15	0.12	0.19	0.13	0.19	0.34	0.36

Note: Shadowed areas indicate that P-values are lower than 5%.

Appendix Table 1: Sales by Item Categories

item categories	sales (1 million yen)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	24,969	38,858	47,951	56,613	67,407	75,491	115,864	149,349	180,689	206,076	262,931	265,886	276,477	301,497	314,058	264,395	306,378	329,340
processed foods	21,873	33,761	41,075	47,990	56,622	63,242	96,884	122,686	147,884	167,924	216,234	219,361	227,069	246,464	255,516	213,968	250,147	267,554
chilled floor	9,364	14,539	17,958	20,877	24,753	27,298	41,637	51,735	60,314	67,812	86,381	86,556	87,969	93,983	97,538	81,702	94,391	100,422
tofu, natto and konnyaku	961	1,520	1,932	2,290	2,766	3,061	4,501	5,714	6,813	7,913	9,923	9,838	9,887	10,566	10,827	8,798	9,794	10,078
pickles and side dishes	1,138	1,781	2,332	2,917	3,465	3,896	5,718	7,291	7,943	8,807	11,293	11,376	11,441	12,079	12,284	10,154	11,874	12,121
pasted fish and chilled half-finished product	2,347	3,548	4,256	4,976	5,819	6,312	9,131	10,945	12,705	13,999	17,148	16,541	16,901	17,959	18,223	14,591	17,265	18,466
meat processed products	1,333	1,934	2,417	2,896	3,455	3,711	5,425	6,615	7,572	8,607	11,056	10,853	11,166	11,710	12,056	10,101	11,328	12,331
milk products and soy milks	2,277	3,647	4,321	4,733	5,497	6,100	9,734	12,200	14,576	16,447	21,046	21,172	20,800	21,638	23,381	19,876	22,092	23,239
chilled desert	308	481	614	738	891	1,089	1,695	2,100	2,381	2,585	3,006	2,882	2,881	3,069	3,092	2,668	3,361	3,955
beverage	1,001	1,629	2,087	2,327	2,860	3,129	5,434	6,870	8,322	9,453	12,908	13,895	14,894	16,962	17,675	15,514	18,677	20,231
room temperature floor	11,307	17,324	20,836	24,350	28,444	32,029	48,703	62,983	77,871	89,438	116,412	119,469	125,228	137,539	143,388	119,776	141,780	152,195
dried products and noodles	982	1,476	1,758	2,031	2,427	2,617	3,967	4,886	5,785	6,380	7,860	7,626	7,540	7,947	7,898	6,280	7,075	7,410
seasonings and sweetening	2,013	3,049	3,556	4,175	4,911	5,283	7,936	9,921	12,134	13,577	16,862	16,788	17,020	17,812	18,130	14,873	17,088	18,034
instant foods	1,715	2,602	3,196	3,673	4,287	4,884	6,976	8,996	11,105	12,151	14,837	15,315	15,375	16,263	16,406	14,052	15,883	16,961
canned products and bottled products	636	931	1,077	1,206	1,395	1,530	2,189	2,597	2,938	3,119	3,705	3,802	3,558	3,576	3,452	2,836	3,106	3,234
bread and mochi	1,266	2,007	2,482	2,916	3,412	3,861	5,772	7,002	8,459	9,266	11,782	12,231	12,762	13,535	14,145	12,153	14,927	16,303
jam, spread and premix	207	322	363	423	501	577	879	1,120	1,368	1,625	2,060	2,040	2,115	2,276	2,373	1,985	2,195	2,475
coffee and tea	1,069	1,518	1,708	1,888	2,163	2,384	3,484	4,489	5,353	5,768	7,533	7,627	7,712	8,217	8,144	6,612	7,078	7,444
sweets	3,093	4,659	5,530	6,351	7,111	7,845	11,129	13,957	16,850	18,382	22,774	23,062	23,991	26,096	26,521	22,787	25,712	27,919
alcoholic drinks	99	185	300	544	790	1,073	2,199	3,463	4,924	6,805	11,636	12,852	15,007	18,598	20,547	18,091	21,953	24,719
baby food, grains and others	228	575	865	1,144	1,448	1,976	4,174	6,553	8,954	12,364	17,363	18,127	20,148	23,217	25,771	20,107	26,764	27,697
frozen floor	1,201	1,898	2,281	2,763	3,425	3,915	6,543	7,967	9,700	10,675	13,442	13,337	13,871	14,941	14,591	12,490	13,976	14,937
frozen foods	777	1,253	1,529	1,827	2,323	2,746	4,532	5,703	7,013	7,629	9,843	9,834	10,231	11,099	10,558	8,853	9,857	10,538
ice cream and ice	424	645	751	936	1,102	1,169	2,011	2,264	2,687	3,046	3,599	3,503	3,640	3,842	4,033	3,637	4,119	4,399
domestic articles	3,097	5,097	6,876	8,623	10,785	12,249	18,980	26,663	32,805	38,152	46,697	46,525	49,408	55,033	58,542	50,427	56,231	61,786
consumable goods	3,049	5,006	6,744	8,463	10,604	12,053	18,559	25,853	31,963	37,101	45,505	45,372	48,011	53,565	57,022	49,079	54,766	59,998
bath and body care goods	401	660	881	1,076	1,332	1,510	2,193	2,664	3,128	3,471	4,222	4,134	4,181	4,335	4,519	3,988	4,710	5,060
oral care goods	203	302	378	463	573	637	905	1,181	1,547	1,709	2,051	1,939	1,938	2,058	2,192	1,815	2,036	2,199
sanitary goods	648	1,092	1,470	1,829	2,162	2,224	2,809	3,511	4,185	4,849	5,944	5,872	6,206	6,718	6,700	5,988	6,499	6,682
detergent	414	682	928	1,187	1,409	1,535	2,249	2,700	3,175	3,574	4,410	4,336	4,391	4,800	4,933	3,982	4,513	4,812
living environmental goods	207	292	391	488	608	649	913	1,180	1,451	1,722	2,144	2,063	2,133	2,308	2,249	1,986	2,024	2,213
cosmetic goods	183	279	352	437	741	1,210	2,285	4,286	5,708	7,270	8,943	9,394	10,892	13,084	15,648	14,376	16,317	18,207
hair cosmetic	131	231	304	384	552	674	1,114	1,643	1,955	2,009	2,179	2,018	2,125	2,294	2,366	2,090	2,294	2,598
fragrance	6	9	11	10	12	16	36	73	79	93	103	100	119	154	170	158	179	232
appearance goods	119	183	229	268	345	382	639	956	1,145	1,251	1,500	1,519	1,556	1,912	2,080	1,747	1,963	2,207
medical related goods and sundry goods	334	539	776	1,017	1,234	1,393	2,191	2,936	3,720	4,320	5,432	5,606	5,850	6,615	6,649	5,377	5,517	6,114
kitchen consumable goods	240	434	571	693	876	970	1,658	2,215	2,577	3,017	3,617	3,421	3,496	3,695	3,702	2,924	3,230	3,468
stationary	13	41	77	102	135	203	531	1,080	1,395	1,620	2,099	2,057	2,013	2,292	2,458	2,007	2,232	2,659
pet food and pet sanitary	149	256	367	488	607	623	898	1,136	1,497	1,786	2,090	2,101	2,164	2,315	2,309	2,032	2,300	2,575
gifts	0	5	11	20	18	26	136	291	400	410	770	812	948	985	1,049	610	951	973
durable goods	48	90	132	160	181	196	421	810	842	1,051	1,193	1,153	1,397	1,468	1,520	1,348	1,465	1,788
wash bowl, bath, kitchen and laundry goods	45	84	110	131	140	144	312	624	630	712	839	760	751	733	802	639	653	721
dishes	2	6	9	15	27	38	102	181	209	295	321	372	633	719	709	705	811	1,065
car goods	0	1	13	14	14	13	7	4	3	44	33	21	13	16	10	4	1	2

Notes: All sales amounts are reported in million yen. The sales amounts of 2003 do not cover sales in November and December.

Appendix Table 2: Standard Deviations for Frequencies of Price Changes

item categories	standard deviations for frequencies of price changes (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	8.2	9.7	10.0	9.5	9.5	9.5	10.1	9.8	10.0	10.6	10.8	11.2	12.7	13.8	14.5	15.5	15.0	15.8
processed foods	8.5	10.0	10.5	10.0	9.9	10.0	10.4	10.3	10.4	10.8	11.0	11.2	12.9	13.9	14.6	15.6	15.0	15.7
chilled floor	10.7	11.6	12.4	12.0	12.4	12.9	13.1	12.9	12.9	13.3	13.4	13.4	14.8	15.6	16.0	17.0	16.0	16.5
tofu, natto and konnyaku	11.9	13.1	14.1	14.0	14.1	14.8	14.6	14.5	14.9	16.3	16.1	15.0	15.5	16.1	15.7	16.0	15.5	15.6
pickles and side dishes	9.5	10.5	11.7	12.6	14.0	14.6	14.0	13.7	13.1	13.3	13.5	14.5	16.1	16.9	17.7	18.6	17.9	18.8
pasted fish and chilled half-finished product	9.5	11.5	12.1	11.8	12.5	13.5	12.6	12.5	12.8	13.1	13.0	13.2	14.3	15.2	15.8	17.0	16.0	16.3
meat processed products	10.4	9.3	10.4	10.1	9.8	11.0	13.4	12.5	12.0	12.5	12.6	13.0	15.0	15.8	16.7	18.5	16.9	17.4
milk products and soy milks	12.0	13.5	14.7	13.0	12.9	13.1	13.3	13.2	12.9	13.6	13.5	13.3	15.0	16.2	16.5	17.5	16.8	17.0
chilled desert	11.4	11.0	11.2	10.1	11.8	11.2	9.6	9.5	10.8	12.4	13.2	13.0	14.8	16.3	17.9	18.7	17.8	17.4
beverage	9.8	8.9	9.5	10.4	10.1	10.0	11.5	11.9	12.0	11.1	11.7	11.7	13.2	13.8	13.9	14.5	13.4	14.1
room temperature floor	6.6	8.3	8.5	7.9	7.6	7.3	8.0	7.9	8.0	8.5	8.8	9.4	11.4	12.7	13.6	14.5	14.3	15.3
dried products and noodles	3.6	4.7	5.2	4.5	4.7	4.8	5.3	4.7	4.7	5.5	6.3	6.9	9.7	11.5	12.9	14.5	14.1	15.0
seasonings and sweetening	5.2	8.4	7.9	7.4	6.7	5.5	5.7	5.2	5.4	5.9	6.5	7.2	9.7	11.6	12.9	14.3	13.8	15.1
instant foods	6.2	6.9	6.9	6.4	6.0	5.6	6.2	5.8	6.4	6.7	7.1	7.8	9.7	11.6	12.1	13.3	12.9	13.8
canned products and bottled products	4.5	5.3	6.2	5.2	5.2	5.1	4.9	5.0	5.3	5.7	6.4	6.8	9.8	11.5	12.6	14.1	13.2	14.4
bread and mochi	15.4	16.3	16.1	15.6	15.4	16.5	17.5	17.3	18.2	18.2	17.3	16.9	17.6	18.6	19.4	20.1	19.0	18.7
jam, spread and premix	4.4	5.5	5.9	5.3	5.9	5.7	5.4	5.1	5.1	6.0	7.2	8.0	9.9	11.7	13.0	14.4	14.3	14.9
coffee and tea	5.9	8.1	7.4	6.7	5.9	6.6	6.1	5.1	5.7	6.0	6.8	7.5	9.8	11.6	13.0	14.5	13.9	14.5
sweets	5.6	6.8	8.2	8.1	7.6	6.8	6.8	7.2	6.5	7.7	8.6	8.8	10.0	11.5	12.5	13.4	12.6	13.3
alcoholic drinks	1.4	1.2	2.2	0.9	1.8	1.9	9.9	9.7	10.0	7.4	6.8	9.4	10.5	10.1	10.6	10.3	12.8	14.2
baby food, grains and others	15.2	15.8	11.6	8.8	11.3	11.8	13.2	12.3	11.7	12.8	12.0	12.0	15.1	16.0	16.2	17.3	16.3	18.3
frozen floor	8.4	12.1	12.3	12.4	11.9	10.6	10.7	10.8	13.3	12.2	13.4	13.3	13.4	13.8	14.8	16.0	14.3	14.3
frozen foods	7.4	12.0	12.2	12.3	12.2	10.5	10.0	10.0	12.8	11.8	13.4	13.0	13.4	14.0	15.0	16.3	14.3	14.4
ice cream and ice	11.1	12.5	12.7	12.9	11.3	11.2	12.8	13.2	14.7	13.3	13.1	14.1	13.5	13.0	14.3	15.1	14.4	14.0
domestic articles	5.5	7.4	6.1	5.9	6.4	6.3	7.5	6.8	7.7	9.6	9.6	10.9	11.6	12.7	13.7	14.9	14.8	16.3
consumable goods	5.6	7.5	6.1	5.9	6.4	6.2	7.4	6.8	7.7	9.6	9.6	10.9	11.6	12.7	13.7	14.9	14.8	16.3
bath and body care goods	3.9	5.1	5.0	5.8	6.3	7.2	8.9	7.2	7.4	9.0	9.7	11.4	12.0	13.4	14.5	15.4	15.2	16.1
oral care goods	2.4	5.0	4.9	5.0	5.7	5.4	7.1	6.6	7.2	8.6	9.4	11.0	11.6	13.3	14.5	15.6	14.1	14.9
sanitary goods	5.7	7.9	7.4	7.8	7.4	6.4	7.5	6.8	7.5	10.1	8.9	10.2	11.0	12.5	14.1	16.2	14.5	15.4
detergent	3.7	6.5	5.6	6.2	6.3	5.3	7.1	5.5	6.1	8.0	8.0	9.5	10.7	12.1	13.8	15.2	14.2	15.8
living environmental goods	3.1	4.4	4.1	5.6	5.9	9.2	8.0	6.8	7.3	9.1	9.2	11.6	12.2	13.3	14.2	15.5	15.7	16.4
cosmetic goods	2.6	3.0	3.2	2.9	4.1	5.3	10.1	8.3	13.0	18.0	17.2	17.3	17.1	17.9	17.8	18.6	17.9	20.3
hair cosmetic	3.7	2.0	2.9	2.8	5.4	6.0	10.4	9.4	9.6	12.1	12.8	13.6	14.2	15.4	15.9	16.8	15.5	16.6
fragrance	0.9	1.2	2.6	3.0	3.3	4.2	4.2	6.2	7.4	14.7	17.2	19.1	13.6	14.7	15.5	17.6	16.0	13.5
appearance goods	2.6	3.4	3.1	4.1	5.7	5.6	7.5	7.0	7.7	10.3	10.9	12.4	13.8	15.0	15.7	16.3	15.1	15.7
medical related goods and sundry goods	14.5	15.5	8.0	5.2	5.6	4.9	5.3	5.5	5.8	6.5	6.9	7.6	8.0	8.8	9.2	10.2	14.0	16.4
kitchen consumable goods	3.3	8.8	8.4	6.4	6.2	5.5	6.2	5.9	6.3	8.2	8.7	10.4	11.2	12.4	13.2	13.9	13.2	14.5
stationary	1.8	1.8	2.2	3.0	7.0	6.3	8.9	6.7	7.6	8.5	9.3	10.5	11.2	11.7	13.7	13.7	13.1	14.5
pet food and pet sanitary	2.6	3.2	3.9	4.7	8.3	10.9	9.3	11.7	11.9	13.0	12.8	13.9	14.0	14.9	15.1	15.7	16.0	17.3
gifts	NaN	NaN	NaN	NaN	NaN	8.0	7.6	6.4	8.9	7.9	8.4	14.1	17.2	15.0	16.3	18.9	22.1	21.3
durable goods	2.4	2.1	2.8	3.3	6.5	7.8	9.8	9.1	10.2	11.6	13.2	14.7	14.7	14.9	16.0	15.8	16.4	17.8
wash bowl, bath, kitchen and laundry goods	2.4	2.2	3.9	4.3	7.6	8.7	10.1	9.2	10.4	11.4	13.5	14.9	14.8	14.7	16.0	15.7	16.6	17.8
dishes	NaN	NaN	NaN	NaN	10.3	9.7	7.7	8.1	8.1	13.5	13.2	15.4	14.6	16.0	16.5	16.7	13.0	18.0
car goods	NaN	NaN	NaN	NaN	NaN	NaN	1.6	NaN	NaN	12.7	9.9	11.2	11.6	14.7	15.3	16.9	40.7	NaN

Notes: The table reports standard deviations of the frequencies across stores. The frequencies are reported in percent per day. We remove the samples that are not sold over 300 days per store when we calculate the frequencies.

Appendix Table 3: Standard Deviations for Frequencies of Regular Price Change

item categories	standard deviations for frequencies of regular price changes (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	1.5	1.9	1.9	1.9	1.9	1.8	1.8	1.9	1.9	2.1	2.1	2.3	2.1	2.3	2.4	2.3	3.0	2.4
processed foods	1.6	1.8	1.8	1.9	1.8	1.7	1.7	1.8	1.8	1.9	1.9	2.1	1.9	2.1	2.1	2.0	2.6	2.1
chilled floor	1.7	1.9	1.8	1.9	1.9	1.8	1.8	1.9	1.8	1.9	1.9	1.9	1.9	2.0	2.1	2.0	2.2	1.8
tofu, natto and konnyaku	1.6	1.9	2.0	2.1	2.1	1.9	1.9	2.1	2.1	2.2	2.3	2.1	2.1	2.2	2.1	2.1	2.2	1.9
pickles and side dishes	1.3	1.3	1.4	1.5	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.8	1.7	1.8	2.0	1.9	1.9	1.8
pasted fish and chilled half-finished product	1.6	1.7	1.6	1.9	1.8	1.7	1.7	1.6	1.6	1.6	1.7	1.6	1.6	1.8	1.9	1.9	2.0	1.7
meat processed products	1.7	1.4	1.3	1.2	1.4	1.3	1.1	1.2	1.3	1.4	1.4	1.4	1.6	1.8	1.9	1.9	1.9	1.5
milk products and soy milks	1.8	2.4	2.3	2.1	2.0	2.0	2.1	2.1	2.0	2.2	2.2	2.1	2.0	2.1	2.2	2.2	2.2	2.0
chilled desert	2.2	2.2	2.2	2.1	2.1	2.0	2.0	2.9	2.3	2.1	2.6	2.6	2.5	3.5	3.2	2.8	3.0	2.4
beverage	1.9	1.9	1.9	1.9	2.0	1.8	1.9	2.1	2.1	2.0	2.0	2.3	2.0	2.0	2.1	2.0	2.6	1.9
room temperature floor	1.4	1.8	1.6	1.7	1.6	1.5	1.6	1.7	1.6	1.7	1.8	2.2	1.9	2.1	2.0	1.9	2.9	2.3
dried products and noodles	1.0	1.4	1.3	1.2	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.3	1.5	1.5	1.5	1.3	2.6	1.6
seasonings and sweetening	1.5	2.1	1.7	1.8	1.8	1.6	1.5	1.7	1.6	1.6	1.6	1.6	1.5	1.6	1.6	1.6	2.8	1.8
instant foods	1.3	1.6	1.6	1.6	1.6	1.4	1.4	1.5	1.6	1.6	1.6	1.6	1.8	3.2	1.8	1.7	2.9	1.9
canned products and bottled products	1.3	1.4	1.5	1.4	1.5	1.4	1.4	1.6	1.8	1.8	1.8	1.5	1.9	2.1	2.0	1.9	2.9	2.0
bread and mochi	1.6	1.7	1.9	2.2	1.9	1.7	1.9	1.9	1.9	1.9	1.9	2.1	2.2	2.4	2.5	2.8	2.8	2.6
jam, spread and premix	1.3	1.6	1.5	1.7	1.6	1.4	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.1	1.9	3.4	2.5
coffee and tea	1.8	2.4	2.0	1.8	1.8	1.8	1.8	1.6	1.7	1.8	1.9	1.9	1.9	1.9	2.0	1.9	3.0	2.6
sweets	1.1	1.5	1.5	1.9	1.6	1.3	1.2	1.4	1.2	1.3	1.2	1.3	1.4	1.5	1.5	1.4	2.5	1.5
alcoholic drinks	0.4	0.5	0.4	0.3	0.6	0.5	2.1	2.2	1.9	1.5	2.4	5.6	1.9	1.9	1.9	1.8	2.3	2.5
baby food, grains and others	2.9	2.7	2.1	2.2	2.1	2.4	2.5	2.9	2.6	2.6	2.7	2.6	2.9	2.7	2.8	2.8	3.9	3.7
frozen floor	2.2	2.3	2.7	2.9	2.9	2.1	1.8	2.2	3.5	3.3	3.0	2.6	2.5	2.7	2.6	2.5	3.9	2.6
frozen foods	1.9	2.1	2.7	2.9	3.0	2.1	1.7	2.0	2.7	2.5	2.8	2.3	2.2	2.3	2.4	2.5	4.0	2.6
ice cream and ice	3.0	3.0	2.7	2.8	2.4	2.4	2.2	2.8	5.8	5.5	3.5	3.4	3.5	3.7	3.2	2.7	3.6	2.8
domestic articles	1.4	2.4	2.3	2.2	2.4	2.4	2.7	2.3	2.4	3.5	3.3	3.9	3.9	4.2	4.7	4.7	5.9	4.8
consumable goods	1.4	2.4	2.3	2.3	2.4	2.4	2.7	2.3	2.4	3.5	3.3	3.8	3.8	4.1	4.7	4.7	5.8	4.8
bath and body care goods	1.8	2.2	2.0	2.0	2.8	3.3	3.4	3.1	2.9	3.8	3.5	4.2	4.1	4.4	4.6	4.7	6.6	4.1
oral care goods	0.8	1.8	1.6	1.7	1.9	1.5	1.6	1.7	1.6	2.9	2.7	3.3	3.3	3.8	4.3	5.3	5.8	4.7
sanitary goods	1.6	3.4	3.7	3.4	2.6	2.4	2.7	2.5	2.9	3.3	3.1	3.3	3.2	3.3	4.0	3.8	4.2	4.0
detergent	1.0	2.2	2.0	1.9	2.1	1.5	3.1	1.4	1.5	2.4	2.2	2.3	2.4	2.3	2.9	2.6	3.9	2.8
living environmental goods	1.6	2.0	2.1	2.3	2.6	2.8	2.4	2.7	2.8	4.3	3.7	4.7	4.7	4.6	4.8	5.0	8.3	5.1
cosmetic goods	0.8	0.7	1.0	1.2	1.9	1.8	5.7	3.4	4.8	6.1	7.0	8.8	8.8	9.4	10.3	11.4	11.0	10.6
hair cosmetic	2.4	1.1	0.9	1.1	3.1	2.9	5.7	5.1	4.9	7.3	6.8	7.9	8.0	8.8	8.8	9.4	10.9	9.8
fragrance	0.0	1.2	1.7	1.5	2.3	3.0	3.6	4.5	5.8	12.1	14.4	16.3	11.6	13.2	10.5	10.1	14.9	8.4
appearance goods	1.2	1.3	1.2	1.3	2.5	1.8	2.6	2.3	2.1	4.4	4.4	5.1	6.3	6.2	7.1	7.0	7.6	5.7
medical related goods and sundry goods	1.9	2.9	2.2	2.6	1.8	2.0	1.6	1.8	1.1	2.5	2.1	2.2	2.1	2.8	2.8	2.1	4.5	4.0
kitchen consumable goods	1.0	1.8	2.0	1.6	2.0	1.6	1.3	1.3	1.3	2.3	2.0	2.3	2.3	2.2	3.2	2.3	3.1	2.1
stationary	1.2	0.7	1.0	1.2	4.6	2.3	3.0	2.0	2.1	3.1	3.1	3.8	4.6	4.4	6.2	5.9	5.4	5.3
pet food and pet sanitary	1.8	1.9	1.6	2.0	4.1	7.5	3.1	3.8	3.6	4.7	4.5	5.2	5.3	5.9	5.5	6.1	7.4	7.1
gifts	NaN	NaN	NaN	NaN	NaN	4.7	5.5	3.4	4.5	3.4	5.2	12.0	5.3	6.7	7.8	6.8	12.0	7.5
durable goods	1.0	1.1	1.7	1.5	2.9	3.9	4.0	3.9	4.3	6.1	6.4	8.0	8.8	8.9	8.9	9.6	10.7	11.3
wash bowl, bath, kitchen and laundry goods	1.0	1.1	2.3	1.9	3.4	4.2	4.0	3.8	4.2	5.8	6.5	8.1	8.8	8.7	8.7	9.2	10.7	11.3
dishes	NaN	NaN	NaN	NaN	8.1	9.4	5.7	5.3	5.5	10.1	7.9	9.0	9.7	9.8	10.1	12.5	10.6	11.5
car goods	NaN	NaN	NaN	NaN	NaN	NaN	1.4	0.0	0.0	2.4	2.8	3.3	5.8	9.9	9.2	12.4	45.9	NaN

Notes: The table reports standard deviations of the frequencies across stores. The frequencies are reported in percent per day. The regular prices denote weekly mode prices by each store. We remove the samples that are not sold over 300 days per store when we calculate the frequencies

Appendix Table 4: Monthly Frequencies of Price Changes

item categories	monthly frequencies of price changes (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	26.4	27.9	30.8	31.2	31.6	39.9	32.1	31.0	30.6	33.1	36.6	38.9	42.2	35.9	39.5	40.2	49.1	40.4
processed foods	28.2	29.6	32.9	33.8	34.2	41.6	34.1	32.9	32.3	34.2	37.6	40.3	43.7	37.9	41.8	42.1	50.8	42.1
chilled floor	30.3	31.8	35.4	35.8	36.9	45.3	38.2	37.6	35.8	37.9	42.4	43.7	46.1	41.3	44.7	46.7	54.4	47.8
tofu, natto and konnyaku	31.9	29.8	33.1	33.9	37.8	52.3	47.7	45.5	39.1	44.5	48.3	49.0	51.3	46.5	46.8	47.1	53.8	48.8
pickles and side dishes	27.4	29.0	30.3	36.2	37.5	46.0	40.0	38.4	35.3	34.2	38.7	41.8	43.7	41.4	44.6	46.0	52.4	47.7
pasted fish and chilled half-finished product	31.0	35.3	36.5	39.0	37.5	46.2	39.5	39.5	37.3	39.0	43.3	45.0	45.6	42.0	45.9	46.8	56.2	48.4
meat processed products	20.0	19.6	29.3	18.8	21.0	29.6	22.7	21.4	22.3	23.7	31.5	33.3	37.7	33.9	39.1	45.8	51.9	44.2
milk products and soy milks	37.8	38.4	44.4	46.7	45.2	52.7	47.5	48.6	43.7	45.8	47.7	48.2	49.6	43.7	46.8	49.5	57.0	50.5
chilled desert	31.5	31.3	34.6	36.1	38.8	46.6	37.5	40.9	40.3	47.5	53.2	54.2	59.7	56.0	55.9	57.1	63.9	59.3
beverage	26.5	29.1	29.8	29.2	36.8	39.2	25.6	22.3	28.8	30.9	37.8	39.0	43.8	36.7	41.4	41.8	51.1	43.4
room temperature floor	26.5	27.6	30.7	32.2	31.6	38.1	30.5	29.4	29.6	31.6	33.7	37.4	41.7	35.4	39.6	38.8	48.7	38.6
dried products and noodles	20.2	20.0	26.3	27.9	27.0	32.4	22.8	24.0	23.1	24.3	29.9	32.1	35.8	30.2	33.3	31.4	45.5	35.2
seasonings and sweetening	31.8	31.6	37.5	37.1	36.9	38.9	34.3	33.4	30.0	31.1	31.9	33.7	39.6	30.6	36.8	36.0	48.9	36.9
instant foods	31.3	32.4	40.1	39.9	34.7	44.7	32.7	29.1	31.6	32.2	33.5	39.2	45.4	38.1	44.2	44.8	55.6	40.2
canned products and bottled products	20.8	21.8	24.5	28.6	24.6	32.8	22.3	23.0	25.3	24.4	28.9	30.6	33.7	32.7	35.3	34.8	42.4	36.0
bread and mochi	29.4	27.8	29.8	30.6	32.0	43.9	40.0	41.7	41.1	42.7	40.2	46.9	49.6	48.9	52.4	52.3	58.0	54.2
jam, spread and premix	14.5	23.7	22.5	26.1	25.1	28.4	20.8	20.6	22.2	24.4	26.5	25.4	31.2	27.9	31.3	31.1	42.5	37.6
coffee and tea	30.8	37.3	32.0	40.9	35.6	41.7	22.5	24.1	30.0	32.4	32.3	37.0	42.3	38.4	43.6	39.6	51.1	39.6
sweets	23.7	24.8	26.1	29.0	32.6	38.9	29.3	26.9	26.2	27.4	31.7	34.4	37.5	29.1	34.1	32.6	44.1	35.8
alcoholic drinks	2.7	6.3	7.2	2.6	4.0	5.2	22.1	23.7	22.4	27.1	29.7	36.2	37.8	23.9	29.7	30.4	35.8	23.7
baby food, grains and others	11.2	18.1	26.1	23.8	25.2	32.5	34.6	30.3	32.9	38.0	40.7	42.5	48.1	47.1	47.0	46.6	55.8	46.8
frozen floor	27.5	32.0	32.5	33.4	36.5	45.1	34.5	30.7	31.3	33.3	40.6	44.4	45.9	39.9	43.9	44.2	48.3	39.6
frozen foods	30.6	32.7	34.2	36.2	40.0	49.6	38.3	33.9	34.7	36.0	44.3	47.5	48.6	41.5	45.0	44.2	46.5	40.8
ice cream and ice	21.8	30.6	29.0	28.0	29.0	34.5	25.9	22.8	22.6	26.7	30.5	35.5	38.2	35.0	40.9	44.2	52.7	36.5
domestic articles	13.6	16.1	18.3	17.0	17.8	31.0	21.7	22.1	22.9	28.0	32.1	32.6	35.3	26.8	29.7	32.0	41.6	33.2
consumable goods	13.8	16.4	18.6	17.2	18.0	31.4	22.0	22.6	23.3	28.5	32.6	33.1	35.8	27.0	30.1	32.5	42.0	33.4
bath and body care goods	16.2	18.4	20.6	14.6	20.3	40.4	33.9	32.2	36.6	35.8	41.9	44.2	44.0	34.6	35.9	39.8	49.0	34.8
oral care goods	14.4	15.7	19.2	20.3	15.0	40.6	24.4	30.2	30.0	33.2	41.8	42.6	47.9	33.1	35.2	35.2	52.3	33.2
sanitary goods	20.5	22.9	28.8	22.4	28.0	43.5	28.2	32.2	36.3	34.7	44.3	41.4	44.1	43.5	45.3	45.5	56.2	46.4
detergent	26.5	28.7	32.6	34.1	28.9	50.2	36.5	37.8	37.9	44.1	42.9	45.6	50.2	39.6	53.3	53.9	65.1	53.8
living environmental goods	15.8	19.2	17.5	19.5	24.9	34.0	29.2	28.2	26.5	34.2	39.3	41.2	44.2	34.8	37.8	40.8	53.5	36.2
cosmetic goods	0.1	5.3	4.3	1.6	1.9	6.2	7.6	9.9	15.0	27.2	29.7	29.2	32.3	17.9	21.9	25.8	31.7	28.5
hair cosmetic	1.1	8.2	2.6	1.4	4.0	21.0	20.9	26.8	22.4	27.6	33.6	30.1	39.6	26.7	28.1	28.5	38.5	30.3
fragrance	0.0	7.5	3.6	0.0	0.0	0.0	0.2	2.6	3.7	4.1	3.9	6.6	5.8	2.5	5.0	8.6	11.0	10.1
appearance goods	1.2	1.9	3.0	8.2	6.2	24.4	17.1	14.7	16.1	21.5	28.5	27.7	37.5	26.1	27.9	32.9	44.8	31.7
medical related goods and sundry goods	1.2	3.0	3.4	5.1	4.8	14.7	5.8	11.2	8.7	15.8	18.3	19.3	16.3	12.4	15.1	19.6	30.2	21.0
kitchen consumable goods	8.3	12.1	13.2	15.5	17.6	22.2	20.4	17.7	18.7	25.4	27.0	29.5	31.8	28.6	30.6	32.2	44.6	32.8
stationary	1.1	4.1	3.0	7.1	4.5	3.5	4.3	8.8	8.6	11.1	12.0	11.9	16.5	9.7	11.2	11.9	17.8	14.9
pet food and pet sanitary	15.6	15.9	19.3	19.8	18.5	34.6	23.7	24.7	20.5	25.2	32.7	32.6	31.9	27.4	29.8	30.7	43.4	37.2
gifts	0.0	0.0	7.5	0.6	9.2	23.2	17.4	10.0	7.6	9.3	15.1	37.3	50.6	49.5	44.8	43.5	53.9	57.9
durable goods	1.2	2.4	2.9	5.5	5.5	7.3	6.2	8.9	6.5	10.4	12.3	11.5	18.5	17.9	16.2	15.3	23.3	29.0
wash bowl, bath, kitchen and laundry goods	1.3	2.6	1.5	4.5	5.5	8.4	5.5	7.5	6.9	10.4	10.5	10.4	17.2	17.1	13.8	13.2	21.1	22.2
dishes	NaN	NaN	6.5	0.6	0.0	2.3	8.8	13.8	5.4	11.1	14.9	12.5	19.9	18.8	18.7	17.3	25.1	33.7
car goods	NaN	NaN	12.8	20.0	16.9	9.8	0.0	5.5	0.2	4.4	33.3	32.5	25.8	12.5	33.2	0.0	0.0	4.5

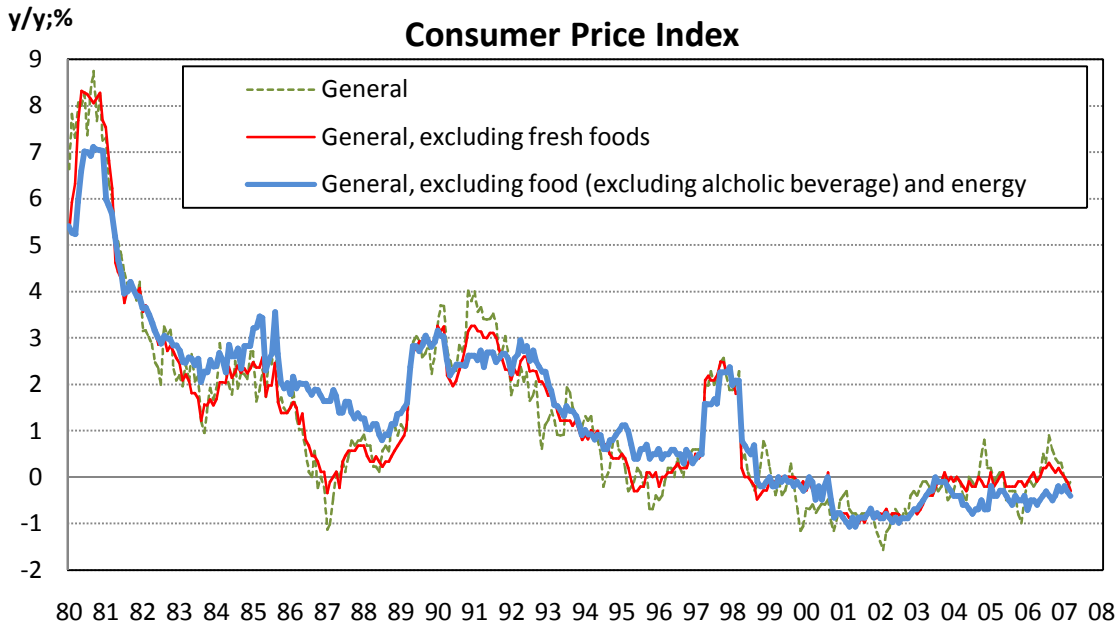
Notes: All frequencies are reported in percent per month. Samples are selected by the condition that they are prices on Wednesday in the week containing 15th day of the month.

Appendix Table 5: Bargain Sales Ratio

item categories	bargain sales ratio (%)																	
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
total	13.1	14.5	14.0	13.3	13.7	15.1	15.5	15.0	14.9	15.5	16.3	17.9	19.2	19.5	19.9	20.4	21.6	23.3
processed foods	14.2	15.6	15.2	14.5	14.8	16.5	16.7	16.5	16.2	16.7	17.7	19.4	20.8	21.1	21.4	21.9	23.0	24.9
chilled floor	15.2	17.0	16.6	15.7	16.6	19.0	19.4	18.8	17.9	18.0	19.2	21.0	22.4	22.5	22.5	23.4	25.0	27.8
tofu, natto and konnyaku	14.8	16.5	16.0	15.6	16.9	20.5	21.4	19.9	19.0	20.1	22.7	23.2	23.2	22.7	22.0	22.3	24.3	26.6
pickles and side dishes	11.4	13.8	14.7	15.9	18.0	20.3	19.9	19.3	17.3	17.2	18.9	20.7	22.0	22.7	23.3	25.0	26.7	29.0
pasted fish and chilled half-finished product	16.2	19.1	18.4	16.5	17.8	20.0	21.2	20.1	18.8	18.8	20.6	22.3	23.6	23.8	24.1	25.0	27.0	29.3
meat processed products	7.8	8.2	8.6	8.4	9.9	12.5	13.6	13.8	13.7	13.0	13.5	16.4	19.7	22.0	24.2	26.9	28.4	31.8
milk products and soy milks	22.5	23.8	23.0	21.4	21.2	24.1	24.0	23.6	22.1	22.0	23.0	25.4	26.5	25.8	24.1	24.7	26.5	29.9
chilled desert	13.3	15.4	14.1	14.6	16.6	18.3	16.7	16.5	17.1	18.5	21.4	23.0	26.7	27.1	26.9	28.1	29.2	30.0
beverage	11.0	12.4	12.1	11.9	11.2	11.9	13.1	12.3	13.0	13.1	13.0	14.9	16.3	16.1	16.5	16.5	17.7	21.0
room temperature floor	12.9	13.7	13.3	12.6	12.8	13.9	13.8	13.8	13.7	14.7	15.2	16.7	18.0	18.5	19.4	19.7	20.6	22.0
dried products and noodles	6.2	7.5	7.8	7.2	7.6	8.7	8.8	7.6	8.0	8.5	9.0	10.4	11.1	12.0	13.2	14.5	16.1	18.0
seasonings and sweetening	16.7	17.5	17.0	16.0	15.0	15.8	15.6	15.0	14.8	15.3	15.6	16.9	17.6	17.6	18.3	18.6	20.6	22.5
instant foods	12.1	13.6	13.6	12.7	13.0	13.6	13.4	12.6	13.3	14.0	14.9	17.0	17.8	17.8	18.0	18.0	19.6	22.2
canned products and bottled products	7.6	9.1	9.4	8.9	9.2	10.1	9.7	9.2	9.0	9.7	11.0	12.8	14.6	14.2	15.2	16.1	18.2	20.8
bread and mochi	21.6	20.6	20.9	20.2	21.6	23.7	25.0	25.3	24.6	26.0	27.9	29.6	31.3	32.4	32.8	33.2	34.1	36.4
jam, spread and premix	4.7	6.2	5.9	5.8	6.1	6.8	6.8	6.6	6.3	7.9	8.4	9.1	10.2	10.6	11.9	13.3	14.5	15.8
coffee and tea	19.1	18.6	16.9	14.9	15.0	16.0	16.6	15.8	15.9	15.2	17.7	19.6	20.8	21.7	22.7	22.4	23.2	25.3
sweets	8.8	9.5	9.4	9.1	9.4	10.0	9.8	9.1	8.9	9.8	10.2	11.0	11.8	12.1	13.3	14.0	15.3	16.3
alcoholic drinks	0.8	1.0	0.8	0.6	1.0	0.9	2.7	4.4	6.0	6.6	6.5	8.3	10.4	11.1	10.8	9.8	10.0	10.5
baby food, grains and others	20.0	21.2	15.2	17.7	18.0	21.6	18.0	22.7	21.0	22.8	22.5	23.7	25.9	27.4	28.7	30.5	28.8	29.8
frozen floor	19.6	22.0	22.3	21.6	19.1	20.5	21.4	21.9	25.4	25.7	29.1	32.8	35.7	35.2	34.4	34.7	34.7	35.6
frozen foods	21.2	25.2	25.3	24.5	21.3	23.0	24.3	24.3	27.8	28.3	32.7	37.1	40.1	39.3	38.6	38.9	38.9	39.5
ice cream and ice	16.6	15.8	16.3	16.1	14.5	14.6	15.0	16.0	19.2	19.4	19.3	20.6	23.2	23.3	23.3	24.5	24.8	26.3
domestic articles	4.9	7.2	6.6	7.1	7.5	8.2	9.0	8.5	9.0	10.1	10.1	10.9	12.2	12.4	13.4	13.7	15.0	16.1
consumable goods	5.0	7.3	6.7	7.2	7.6	8.3	9.2	8.7	9.1	10.2	10.2	11.1	12.4	12.5	13.6	13.9	15.2	16.3
bath and body care goods	3.6	5.2	4.9	5.5	6.2	7.7	9.2	9.2	9.1	10.0	10.1	11.0	11.8	13.0	15.0	16.3	17.3	19.0
oral care goods	2.5	4.1	4.6	4.8	6.2	7.3	7.7	8.1	8.1	8.6	8.5	9.4	10.7	11.4	13.1	14.0	15.2	17.1
sanitary goods	10.3	14.4	12.7	13.6	13.0	14.1	17.4	16.3	17.4	18.5	18.5	20.7	23.1	22.9	24.0	25.4	26.8	29.6
detergent	10.1	14.2	12.2	13.5	14.4	15.5	17.8	17.5	17.2	18.5	19.2	20.0	22.0	21.3	22.9	24.1	25.6	28.4
living environmental goods	2.7	3.7	3.6	3.9	5.2	6.6	7.5	7.3	7.4	7.9	7.7	9.5	11.1	12.6	13.8	15.7	16.0	18.8
cosmetic goods	0.8	1.4	1.4	1.3	2.0	2.0	3.0	4.2	7.0	10.0	9.7	9.6	10.5	10.5	10.7	10.2	12.1	12.1
hair cosmetic	0.5	1.0	1.3	1.1	2.5	3.4	4.0	4.6	4.4	4.7	4.8	5.0	6.4	6.9	8.1	9.0	9.1	10.6
fragrance	0.1	0.5	0.5	0.3	0.7	0.6	1.4	1.7	2.2	2.7	2.8	2.7	3.5	3.2	3.7	4.7	4.1	4.7
appearance goods	0.6	1.2	1.6	1.9	3.2	4.0	4.2	4.9	5.2	5.7	5.8	6.3	7.5	9.5	11.2	11.6	11.8	12.5
medical related goods and sundry goods	1.9	2.7	2.7	2.1	2.7	3.5	4.2	4.4	4.4	4.7	4.5	4.9	5.5	5.7	6.9	5.9	6.9	8.2
kitchen consumable goods	3.0	6.1	5.8	6.0	7.7	9.5	9.9	9.3	9.6	9.9	10.3	11.9	13.0	13.4	14.6	14.9	16.9	18.4
stationary	0.4	0.8	0.8	1.3	1.6	2.4	3.0	3.4	3.2	4.0	3.5	3.8	5.1	5.4	7.1	6.9	7.2	8.6
pet food and pet sanitary	1.4	2.1	2.5	3.2	4.4	5.6	5.8	7.5	7.1	7.7	7.8	9.0	9.9	10.3	11.6	12.2	13.8	15.1
gifts	0.0	3.2	3.3	7.2	3.9	2.9	5.3	4.2	3.6	4.6	4.7	8.1	11.5	12.2	15.1	15.9	15.4	15.7
durable goods	0.4	1.2	1.1	1.3	1.8	2.7	3.7	4.5	4.4	5.3	4.6	5.1	6.1	6.2	7.2	8.2	9.0	11.0
wash bowl, bath, kitchen and laundry goods	0.3	1.2	1.2	1.2	1.8	2.8	3.9	4.6	4.3	4.9	4.4	4.7	5.4	5.5	6.7	7.3	8.1	9.1
dishes	0.9	2.1	0.5	2.5	2.2	3.1	3.3	4.2	4.7	5.4	5.1	5.7	7.0	6.9	7.7	8.9	9.8	12.3
car goods	0.0	0.7	0.8	0.4	0.6	0.6	0.6	0.8	0.8	10.4	6.4	5.6	4.2	7.6	9.8	8.0	4.4	7.3

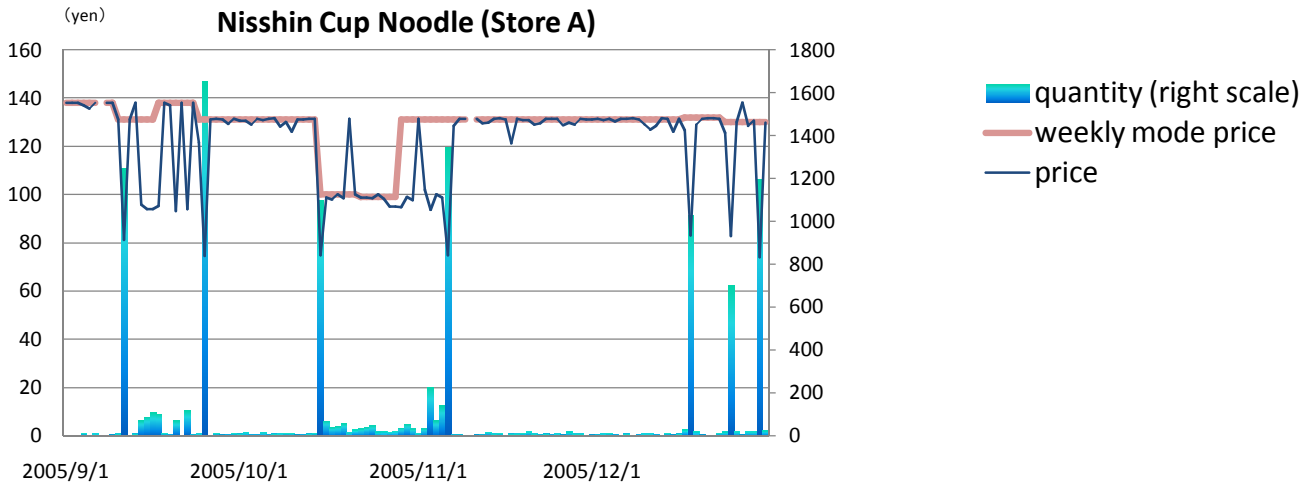
Notes: The bargain sales ratio is the ratio of the amount of selling during bargain sales to the amount of total selling. The definition of bargain sales are denoted in the APPENDIX.

Figure 1

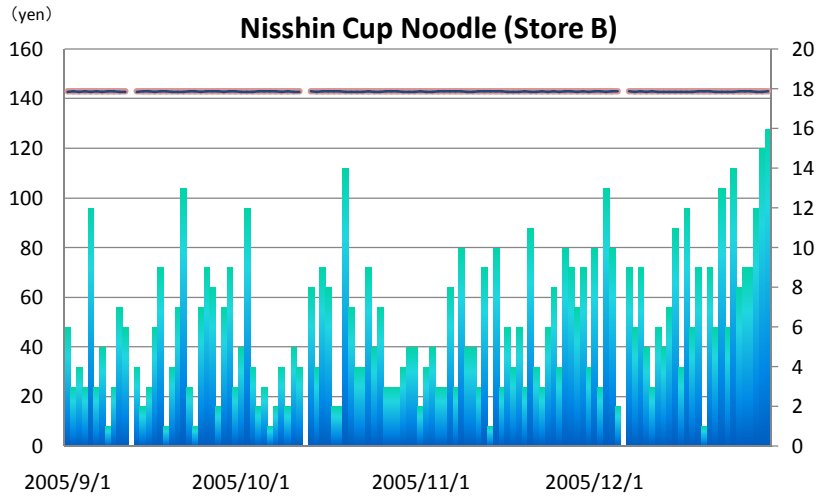


Source: Ministry of Internal Affairs and Communictions, "Consumer Price Index."
Note: The inflation rates include positive effects of raising cosumer tax rate.

Figure 2
(a)


(yen)
Nisshin Cup Noodle (Store A)
160
140
120
100
80
60
40
20
0
1800
1600
1400
1200
1000
800
600
400
200
0
2005/9/1
2005/10/1
2005/11/1
2005/12/1
quantity (right scale)
weekly mode price
price

(b)


(yen)
Nisshin Cup Noodle (Store B)
160
140
120
100
80
60
40
20
0
20
18
16
14
12
10
8
6
4
2
0
2005/9/1
2005/10/1
2005/11/1
2005/12/1

(c)

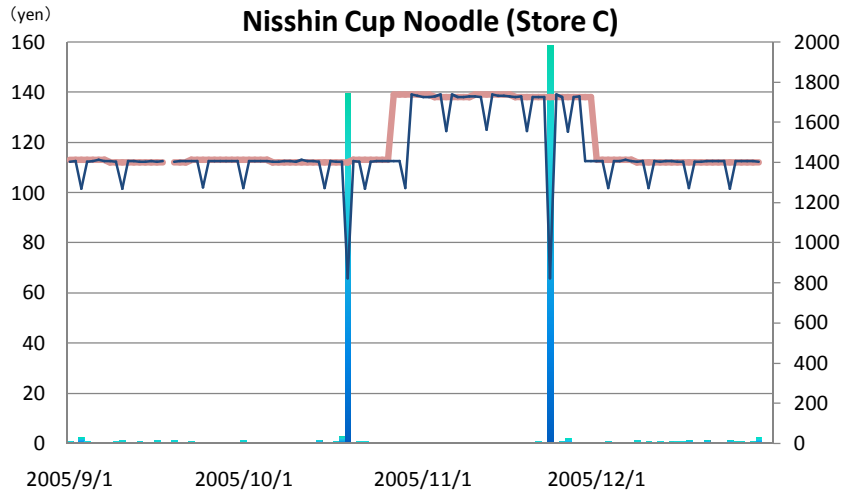
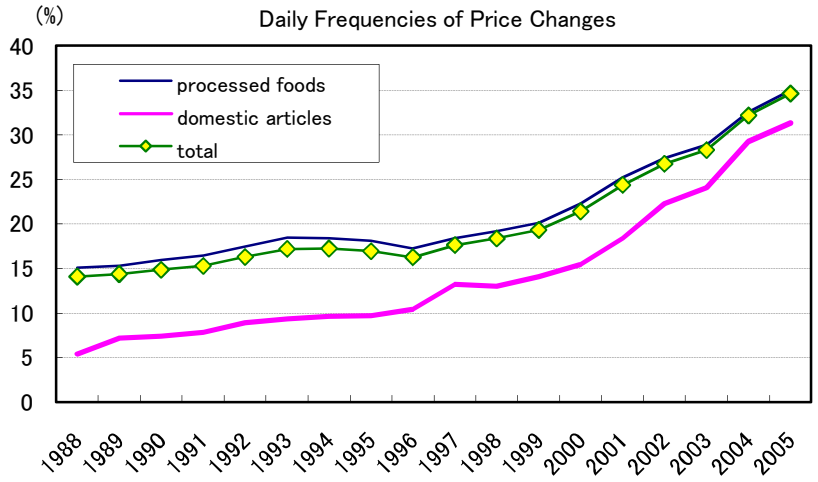
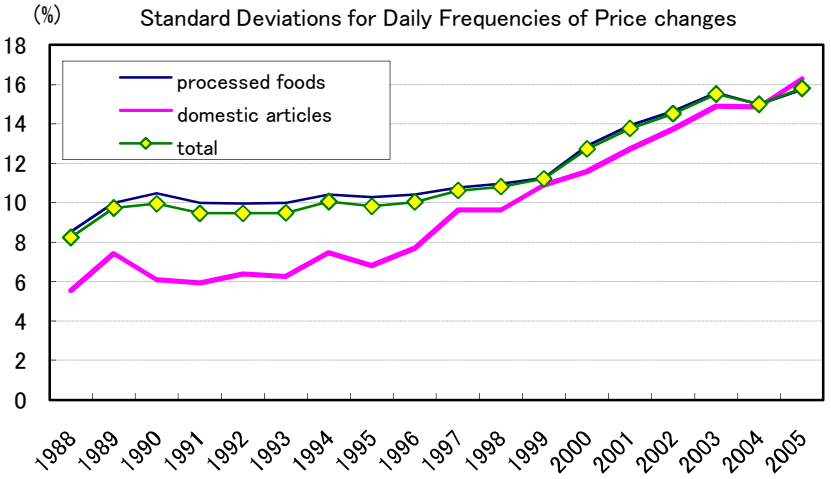

(yen)
Nisshin Cup Noodle (Store C)
160
140
120
100
80
60
40
20
0
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2005/9/1
2005/10/1
2005/11/1
2005/12/1

Figure 3



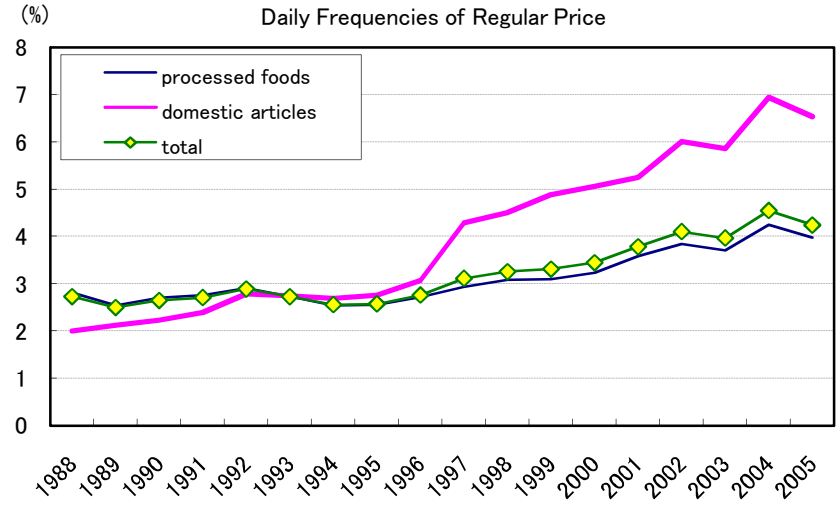
Note: We remove the samples that are not sold over 300 days per store when we calculate the frequencies.

Figure 4



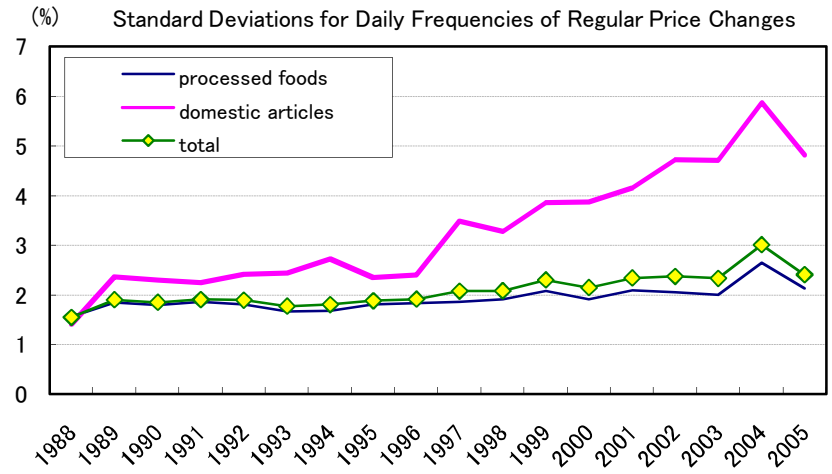
Note: We remove the samples that are not sold over 300 days per store when we calculate the frequencies. The standard deviations of the frequencies are across stores.

Figure 5



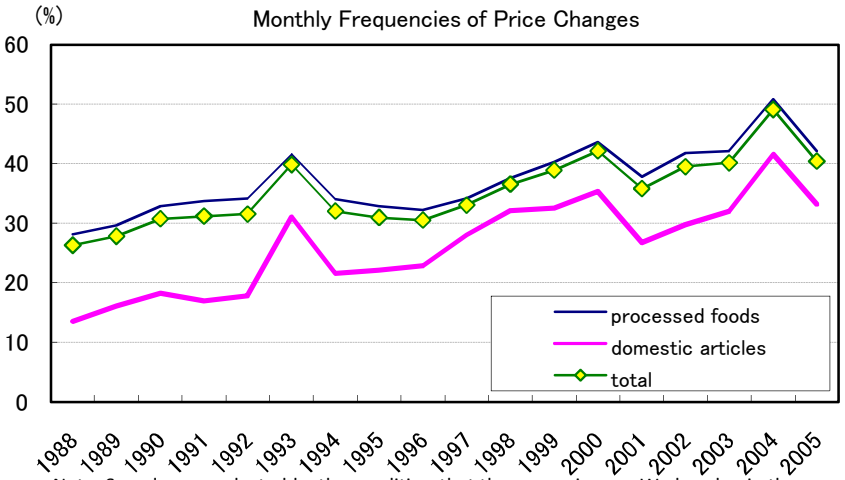
Note: We remove the samples that are not sold over 300 days per store when we calculate the frequencies.

Figure 6



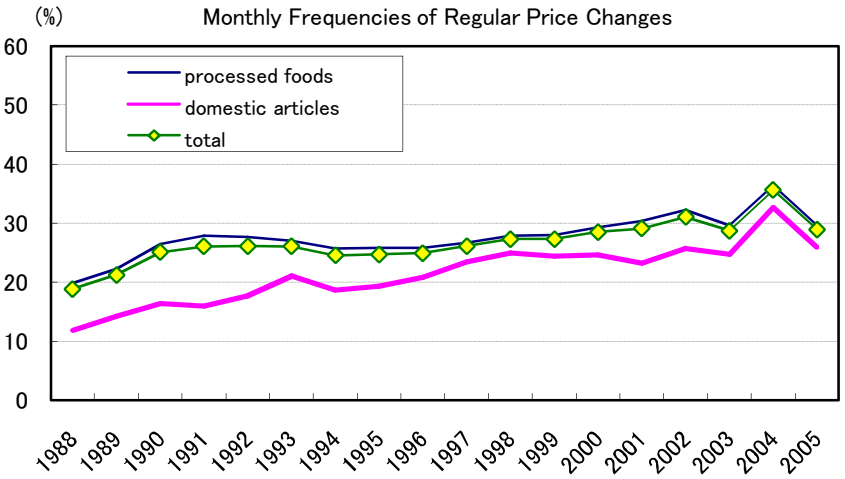
Note: We remove the samples that are not sold over 300 days per store when we calculate the frequencies. The standard deviations of the frequencies are across stores.

Figure 7



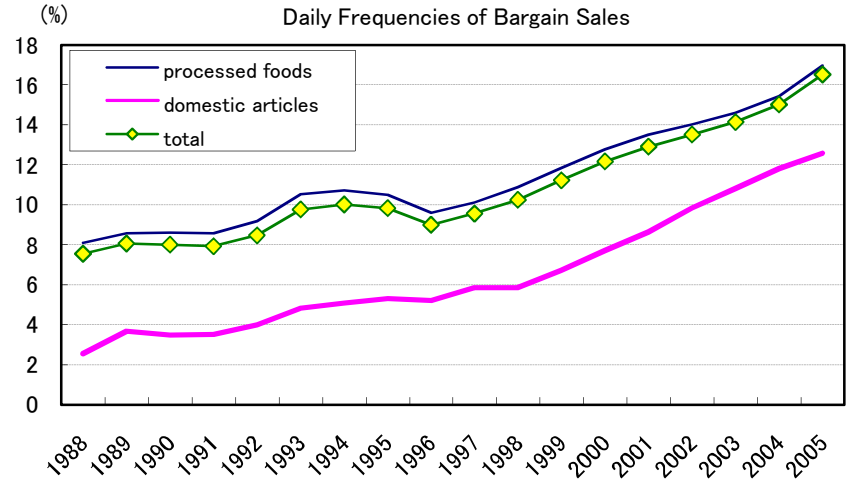
Note: Samples are selected by the condition that they are prices on Wednesday in the week containing 15th day in one month.

Figure 8



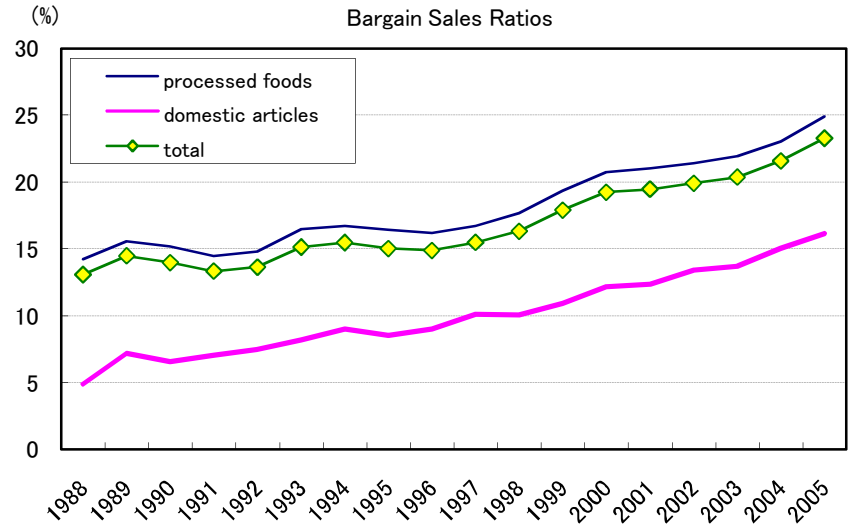
Note: Samples are selected by the condition that they are prices on Wednesday in the week

Figure 9



Note: We remove the samples that are not sold over 300 days per store when we calculate the frequencies.

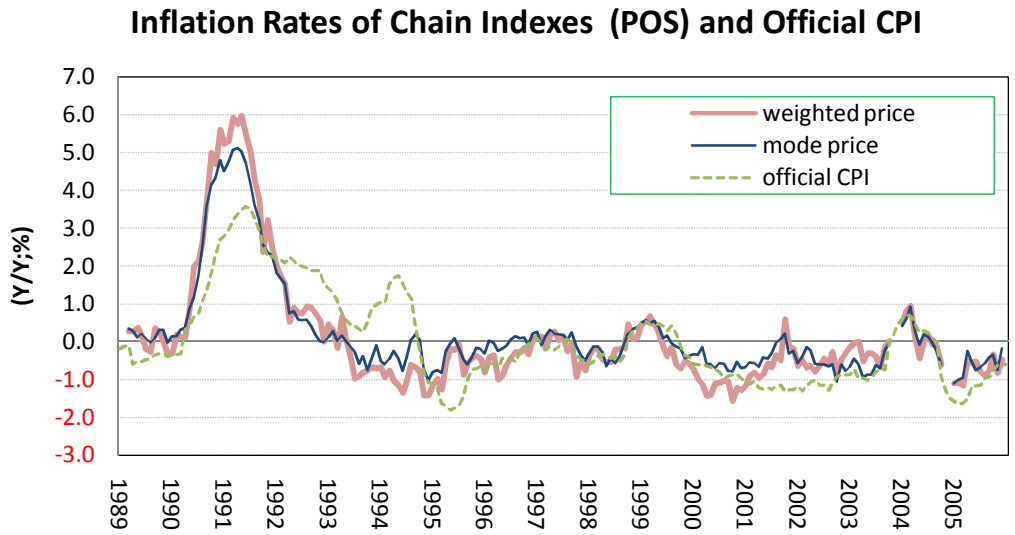
Figure 10



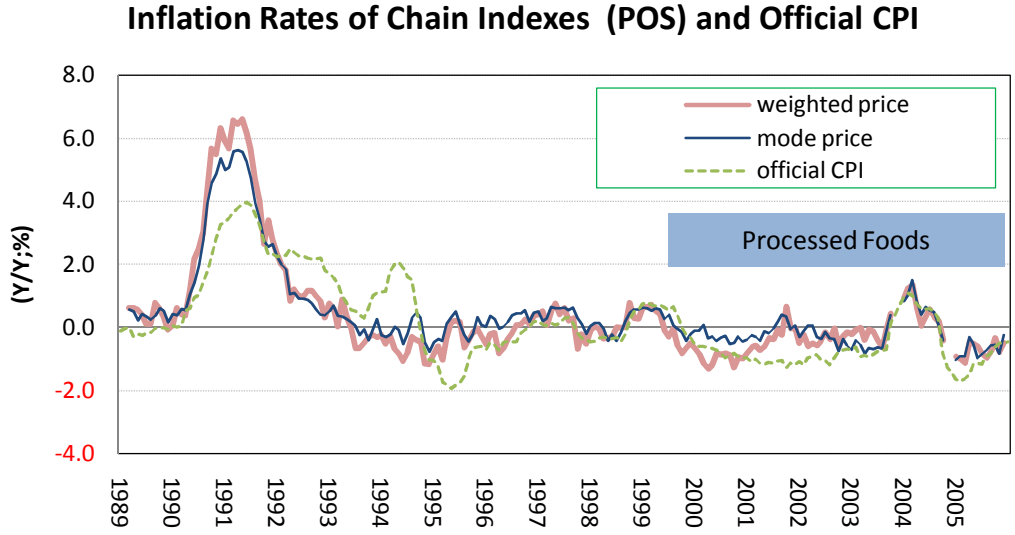
Notes: The bargain sales ratio is the ratio of the amount of selling during bargain sales to the amount of total selling.

Figure 11

(a)



(b)



(c)

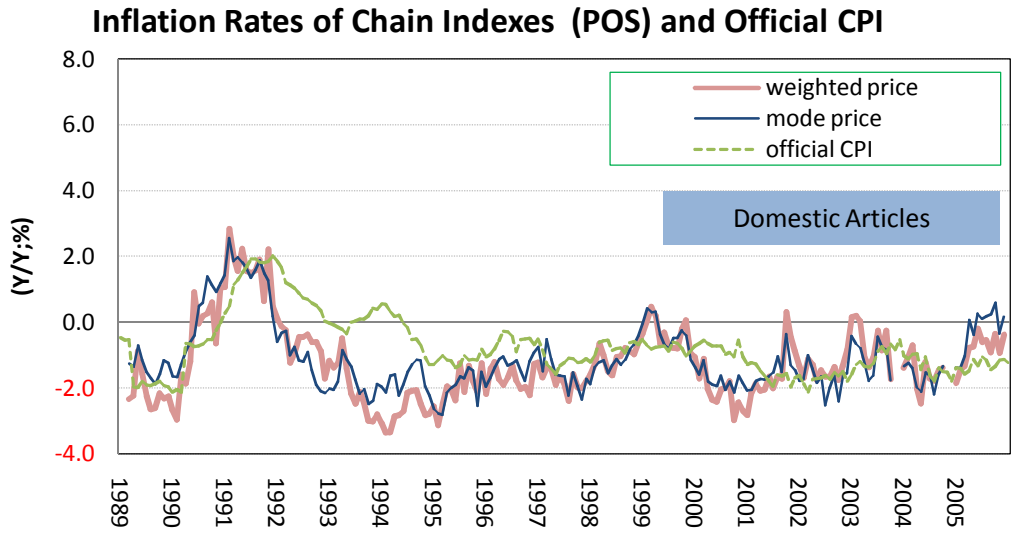
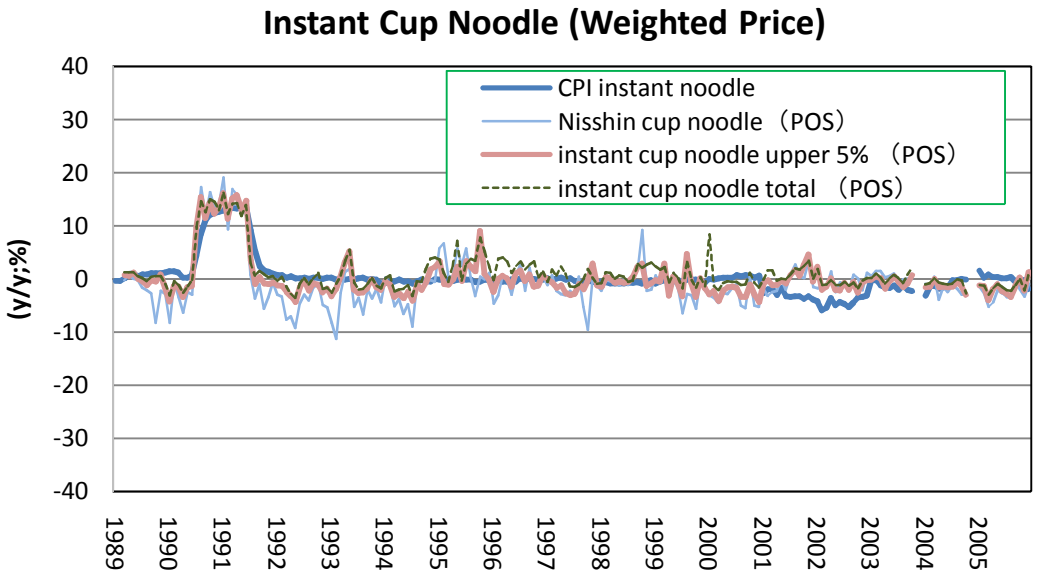
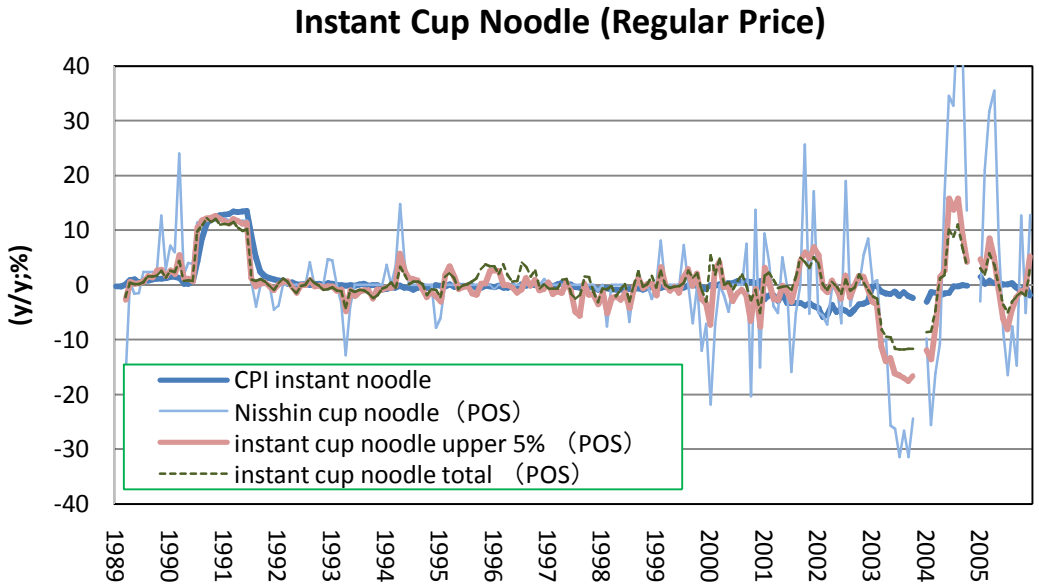


Figure 12
(a)



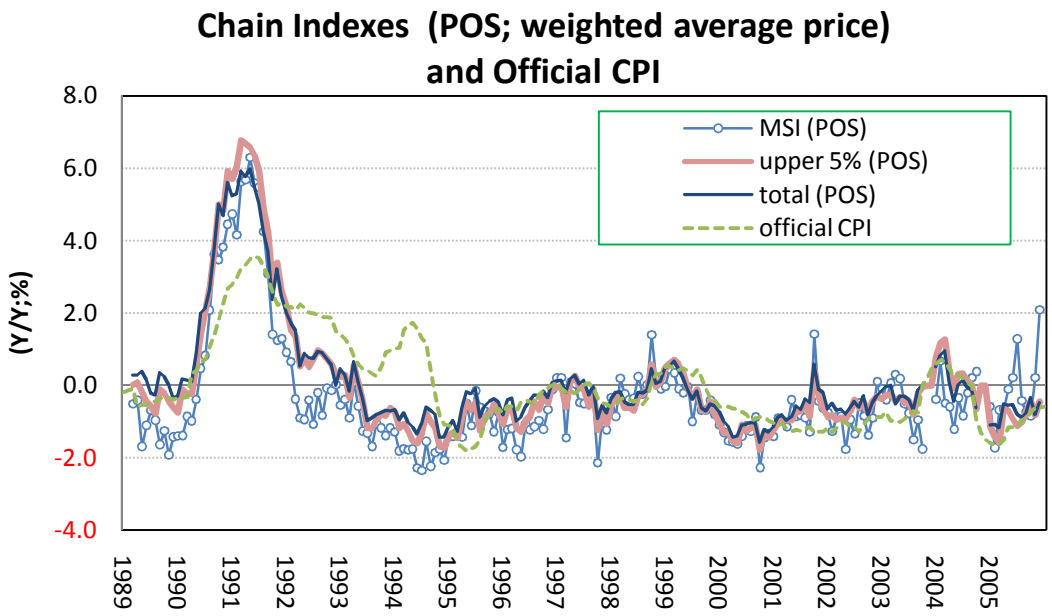
Note: "MSI" denotes the most sold item in the item category.
"upper 5%" denotes the upper 5% of items for the number of sold months in the item category.

(b)



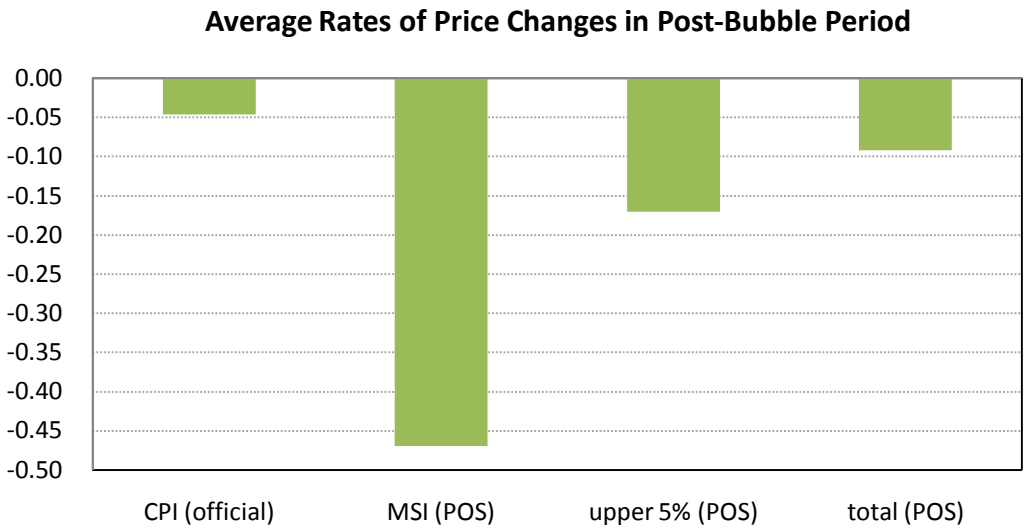
Note: "MSI" denotes the most sold item in the item category.
"upper 5%" denotes the upper 5% of items for the number of sold months in the item category.

Figure 13



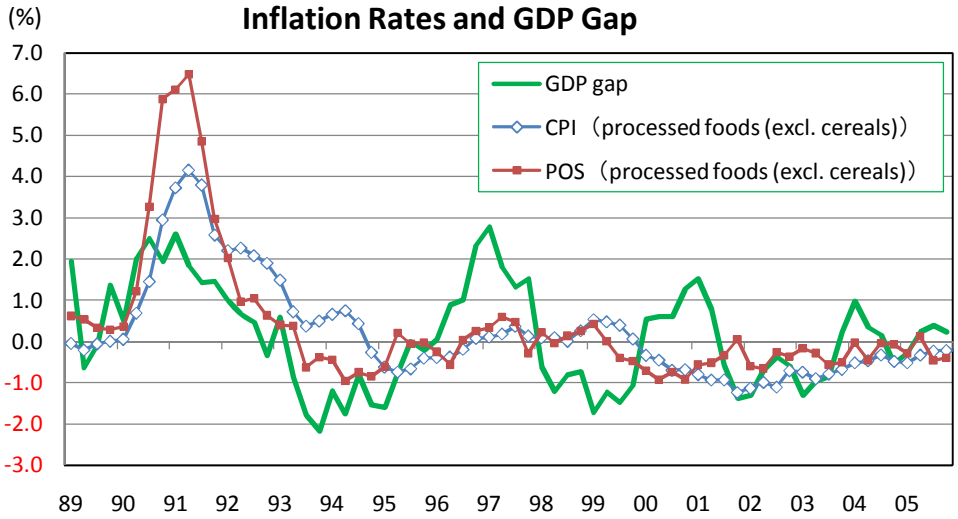
Note: "MSI" denotes the most sold item in the item category.
"upper 5%" denotes the upper 5% of items for the number of sold months in the item category.

Figure 14



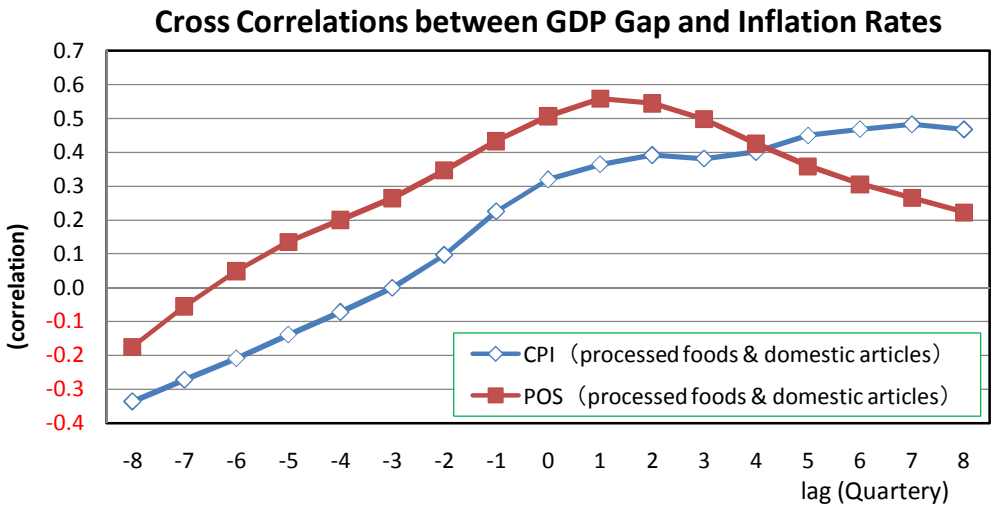
Note: "MSI" denotes the most sold item in the item category.
"upper 5%" denotes the upper 5% of items for the number of sold months in the item category.
The Post -Bubble period is from March, 1991 to December, 2005.

Figure 15



Note: Inflation rates are year on year rates. GDP gap is H-P filtered log of real GDP (λ=1600).
CPI excludes the positive effects of raising consumer tax rate.

Figure 16
(a)



(b)