Introduction to the UTokyo Daily Price Index

Measuring the Daily Price Index Using Scanner Data in Japan

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What Is the UTokyo Daily Price Index?

Japan has spent the last decade and a half in deflation, a gradual decline in the price level. The current administration has made stopping deflation one of its top priority challenges. In January, the government and the Bank of Japan (BOJ) issued a joint statement setting "the price stability target at 2% in terms of the year-on-year rate of change in the consumer price index". The future direction of price levels in Japan has increasingly become the subject of focus at home and abroad.

The UTokyo Daily Price Index (www.cmdlab.co.jp/price_u-tokyo/pg1e.html) project was launched with the objective of measuring and publishing a price index (inflation rate) with emphasis on "high frequency" and "high precision" by using scanner data collected by point of sale (POS) systems, which record and manage sales results of individual products when the transactions for the merchandise are completed at the cash registers, in approximately 300 supermarkets sampled from all over Japan.

High frequency: While the official consumer price index (CPI) is currently announced once a month with a one-month time lag, the UTokyo Daily Price Index is in principle renewed every day and provides information on the inflation rate with only a three-day delay. Also made public are the historical inflation rate data, measured by using the scanner data of approximately 6 billion transactions collected since 1988.

High precision: First, the project adopts the calculation method for the Törnqvist index, known in the area of price index theory as one of the superlative price indexes. Second, the project makes use of the most significant feature of scanner data, the potential for the observation of the prices and sales values of all the merchandise sold in each store, and measures the price index on the basis of complete count surveys in the sampled stores by continuously taking the fluctuations in the prices of all the merchandise actually sold and calculating their weighted average as the reflection of the respective shares in sales volume at each point of calculation.

Measuring and publishing a high-frequency, high-precision price index through the UTokyo Daily Price Index makes it possible to monitor the effects of policy measures at a more granular level. It will also enable effective confirmation of an escape from deflation in a timely manner. It can also be useful as an indicator for monitoring sudden, unforeseen price fluctuations. Hopefully, it will help make price formation in stock, foreign exchange, sovereign bond and other such markets more efficient as market players use it together with other market data to form expectations of future price trends. It will also provide timely information on price movements in individual industries by providing itemized indexes, and can also be used by individual manufacturers or retailers in their pricing strategies since they can observe the inflation rates for their respective product categories.

Difficulties in Measuring Price Indexes

Japan's consumer price index is produced according to the international standards established by the International Labour Organization (ILO), as is the case in other major countries. However, this is not necessarily the single best index. The measurement methodology for price indexes has long been the subject of academic and practical debate; there is much room for improvement.

For example, in Japan, the CPI is measured using the fixed base Laspeyres formula under the assumption that the price fluctuations for the wide range of goods and services that consumers consume in a year can be represented by the price fluctuations of less than 600 representative items selected at a base date and that they consume those items in the same proportions over the five years from the base date.

However, consumers act to secure the cheapest merchandise possible at the cheapest store possible, and it is believed this tendency is particularly prominent in Japan as a result of the protracted economic downturn. At the other end, manufacturers, retailers, and other businesses compete against each other to draw consumers out of their weak-demand shells through new products, special sales strategies, lowest price guarantees, and other means.

For example, take an item like chocolate. A visit to a Japanese supermarket will present the customer with a vast array of chocolate products on its shelves, as well as plenty of other confectionaries that can serve as substitutes. This means that when the price level of products in the chocolate category rises because of an exogenous shock, this will cause a change in buying behavior, such as a shift in consumption to substitute goods.

In this case, using the Laspeyres formula that fixes consumption proportions means that the decrease in the weight of chocolate consumption will not be reflected, leading to the overweighting of the increase of chocolate price levels in calculating the consumer price index.

Moreover, in Japan, only one brand is surveyed for each category as a general rule, i.e. the price of only one representative product (best-

selling product) for each category is collected. In reality, however, not all product prices rise at the same rate in the event of an inflationary shock. It is quite possible that consumers will shift consumption to a different chocolate brand whose price has not been raised.

If the CPI is to be seen as a means of understanding the cost to the consumer of enjoying a certain standard of living, it is necessary to pursue these dynamic and heterogeneous changes in the buying behavior of consumers and price-setting behavior of firms and to reflect them in the price index.

However, the authorities who are responsible for issuing the price index must collect price information by dispatching enumerators to actual stores under severe budgetary constraints. It is all they can do to survey prices for predetermined products at predetermined stores.

How much is the CPI distorted by the inability to grasp the dynamic changes in economic activities? This problem has been analyzed extensively since the 1996 Boskin Commission Report issued by the Advisory Commission to Study the Consumer Price Index established by the US Senate Finance Committee. The size of measurement error or bias of each factor, such as the substitution effect of the fluctuations of relative prices, the transfer effect of consumers to discount stores, the effect of the introduction of new products, and quality adjustments, has been analyzed in detail. Consequently, a consensus has been formed on the upward bias manifested in the consumer price index, which the authorities responsible for producing the consumer index have worked to correct.

Measuring Price Index Using Scanner Data

It is impossible to encompass dynamic changes in economic activities in their entirety in a consumer price index as long as the index is based on sample survey data. Would it be possible, though, to provide a consumer index with higher precision and do it more swiftly at relatively low cost?

In Switzerland, the Netherlands, and some other European countries, efforts have begun to develop consumer price indexes using scanner data. Scanner data consist of information collected at supermarket checkout counters when the barcode symbols on the products are read off. The data record when, what, and how much was purchased product by product, providing us with all the information concerning the sales history in each store.

Since the data are stored electronically in real time, it is possible to calculate and publish daily inflation rates by receiving and tabulating the data from all the stores.

A conventional CPI uses the assumption that consumers continue to consume a fixed consumption basket. However, by using scanner data, it is possible to track the daily changes of the representative products (best-selling products) through their shares of sales and reflect the outcome in the consumer index immediately and appropriately.

There is no need to sample data for representative products since the all the information concerning all the products sold on any given day is available from the scanner data.

Producing UTokyo Daily Price Index

The scanner data used to measure the UTokyo Daily Price Index are the daily data for all products sold in approximately 300 stores sampled throughout Japan.

A single record in the scanner data consists of the number of units and the total value of a given product sold on a given day in a given store. Approximately 6 billion such records for approximately 2 million products cumulatively sold from 1988 up to now have been accumulated. These records are updated daily with the latest data. The ever wider variety of products available, together with other factors, means that the amount of data accumulated is increasing every year. In 2012, the numbers of products sold and their records were approximately 350,000 and 0.4 billion, respectively.

The stores being sampled are supermarkets that sell processed food, beverages, household goods and the like. Consumer electrical appliances and other consumer durables, services, and the like are not covered by the data. Thus, the scanner data only cover about 30% of the product items covered by the official consumer price index and 17% of the official CPI in terms of consumption weight (base year 2010) according to the Family Income and Expenditure Survey. Therefore, when matching our index against the official consumer price index, the summary value of the price indexes of the product items that can be matched against the scanner data is used. We call this summary CPI (official groceries).

The products for which the data are collected are sorted into the approximately 200 categories (e.g. tofu and tofu products, chocolate, shampoo) defined by Nikkei Digital Media, Inc. The price changes for individual products are aggregated for the UTokyo Daily Price Index using these categories.

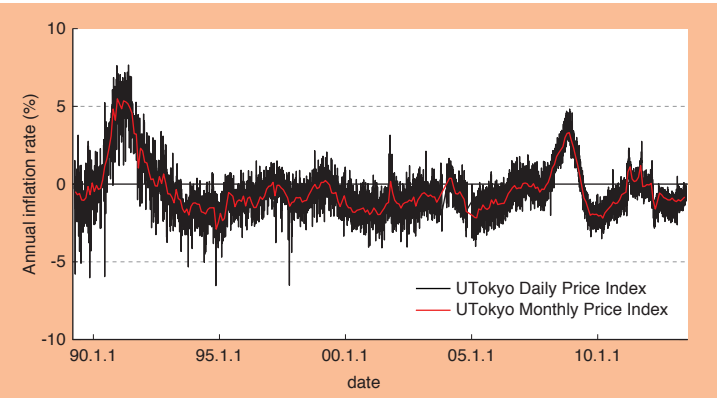
Our index is calculated as the weighted geometric mean of the price ratios between the current and base periods, i.e. same day of the previous year, for each product using the Törnqvist formula. The Törnqvist formula calculates the geometric average of changes in the price of a product weighted by the arithmetic average of the value shares of the product for the two periods. The formula allows our index to incorporate day-to-day changes of best-selling products.

The UTokyo Daily Price Index is not calculated in a single step. Instead, it is compiled in three stages: 1) (lower level aggregation) produce an index for each product category in each store from price fluctuations of individual products; 2) (middle level aggregation) produce an all-stores index for each product category by aggregating the indexes produced in stage 1 over stores; and 3) (upper level aggregation) produce the UTokyo Daily Price Index (composite index) by aggregating the indexes produced in stage 2 over product categories.

The UTokyo Daily Price Index project also publishes a monthly index produced in the following manner. Each month, the unit sales price (monthly price) of each product is calculated from the consolidated sales prices and sales volumes recorded in the daily scanner data for that month. The unit sales prices are then used to calculate the

CHART 1

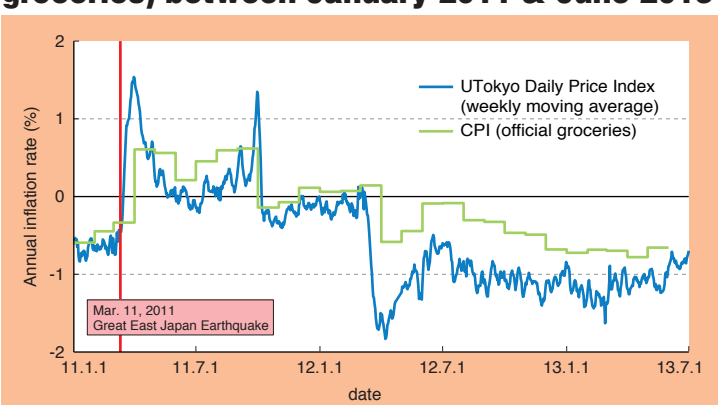
UTokyo Price Index between April 1989 & June 2013



Note: Indexes for November and December 2003 and November and December 2004 are missing because the data for November and December 2003 do not exist.
Source: Compiled by author

CHART 2

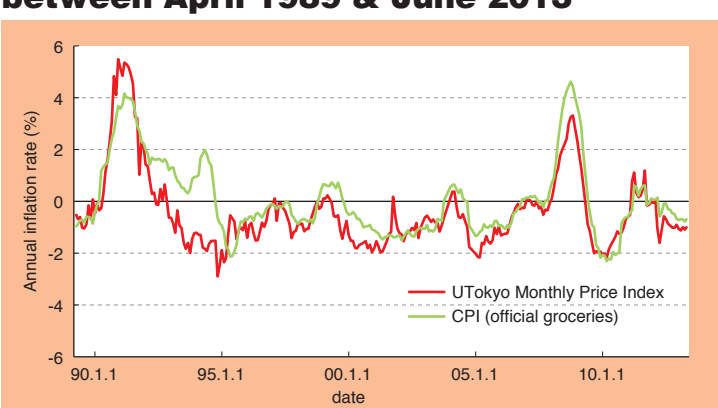
Comparison between a weekly moving average of UTokyo Daily Price Index & CPI (official groceries) between January 2011 & June 2013



Source: Compiled by author

CHART 3

Comparison between UTokyo Monthly Price Index & CPI (official groceries) between April 1989 & June 2013



Source: Compiled by author

inflation rate in three stages just as is the case with the daily data. This monthly index will be referred to in this report as the UTokyo Monthly Price Index.

Chart 1 displays the comprehensive indexes for the UTokyo Daily Price Index and the UTokyo Monthly Price Index between April 1989 and June 2013. It shows that volatility is vastly higher in the daily index. The daily inflation rate is affected by day-of-the-week factors and special-sales patterns unique to individual stores, which enhance volatility. This kind of volatility can be reduced by applying time-series filters and other means. In addition to the current inflation rate data, our project website also publishes moving averages for the seven preceding days.

Chart 2 provides a comparison between a seven-day moving average (daily time series) of the UTokyo Daily Price Index and the CPI (official groceries) between January 2011 and June 2013. It shows the inflation rate, which had been holding at around minus 0.7%, jumped to around 1.5% within 20 days of the Great East Japan Earthquake on March 11, 2011 as a result of the rapid rise in demand for water, food, and other daily necessities. It is possible to detect these sudden fluctuations in price levels by using the daily index.

Chart 3 is a comparison of the UTokyo Monthly Index and the CPI (official groceries). The time-series characteristics of the two indexes are broadly similar, but our index is about 0.5 percentage points lower as temporal averages. Historically, our index fell rapidly when the economic bubble burst, the inflation rate dipping into negative territory in June 1992. If the beginning of deflation is defined as the inflation rate turning negative, then deflation as measured by our index preceded deflation under the CPI (official groceries) by 28 months. This is just one of the differences between the two indexes.

There are many differences between the UTokyo Daily Price Index and the CPI, such as the products and stores surveyed and the index calculation method. The causes of the differences in the measured values such as those that we referred to above should be explored in detail on another occasion.

We will continue to expand the UTokyo Daily Price Index project in order to make it an effective platform for the analysis and research of inflation dynamics while improving the accuracy of our measurements and aiming to publish item-by-item indexes and volume indexes. We will also aim at the provisional publication of information such as the frequency of price changes and special sales and the size of price changes.

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