

Statistical properties of purchase number fluctuations in Japanese supermarkets

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We analyze huge data-base of Point-of-Sale system of supermarkets in Japan. It is consisted of about 1.4 million kinds of items sold in about 400 supermarkets in Japan for the period of 1988-2008. The time stamp is daily and the numbers of sold items in each supermarket are recorded with prices.

In Japanese supermarkets, items are sold mainly at regular price and sometimes sold at bargain sales by lower prices. For example the number of daily sales of a kind of cup-noodle at a shop is about 20 at regular price, however, the number of sales becomes about 2000 when sold at about a half of regular price. As typically known from this example the price change affects the number of sales greatly in general. We investigate such effects of price change to the number of sales.

The first step of this study is to define the regular price from the given price time series. We define the mode price of time series as regular price in each item. After defining the regular price we analyze the sales number fluctuation at regular price. We confirm that the number fluctuation of sales at regular price is described well by a Poisson process for most of items as expected.

Then, we investigate the effect of bargain sales. We pay attention to the relation between price change and resulting change of number of sales. For most of items we confirm that the following inverse power law holds, where $p(t)$ and $s(t)$ denote the price and the number of sales at the t -th day, respectively.

$$S[t+1]/S[t] = (P[t+1]/P[t])^{-\alpha} \quad (1)$$

Namely, the number change at a bargain sale day is characterized by the ratio of the price and number of the day before. The exponent of α depends on the category of items. For example, the exponent of Instant food is about 4. There is a tendency for foods that the exponent of α of short life item is generally smaller than that of long life item.

Keywords

retail, Poisson process, Power law, time series analysis.