(Box 4) Weather Effects and Private Consumption

Weather conditions, such as temperature and precipitation, have a large influence on consumption of seasonal merchandise, such as clothing and air conditioners. Indeed, a strong link between weather conditions and consumption developments is often referred to in the Bank's interviews with firms and comments in the *Economy Watchers Survey*.

This link could be quantitatively examined by estimating a simple consumption function where regional real retail sales are a dependent variable and explanatory variables include wages, regional temperatures (measured by deviations from normal temperatures), and regional precipitation (measured by deviations from normal precipitation) (Box Chart 4 [1]). The regression equation takes into account the possibility that the response of private consumption could be asymmetric between high and low temperatures and between high and low precipitation, relative to the past averages.

The estimation results show that the effects of weather conditions on private consumption are statistically significant especially in June, September, and November, which correspond to the timing of seasonal transitions in Japan. A rough evaluation of the weather effects in past years based on the regression results shows that irregular weather negatively affected private consumption in the April-June and October-December quarters of 2015 (Box Chart 4 [2]). In particular, the contribution of weather effects on quarterly real retail sales growth in the October-December quarter was about minus 0.7 percentage point, the largest negative figure in the past decade, suggesting that the high temperature and heavy rainfall at that time of the year considerably pushed down private consumption.

Goods consumption, which is measured by the retail sales, constitutes about 50 percent of private consumption (GDP consumption, all items less imputed rent basis); thus, the irregular weather dampened quarterly real private consumption growth in the October-December quarter of 2015 by about 0.4 percentage point. The growth rate of the consumption activity index for the October-December quarter of 2015 was minus 0.5 percent, but when the negative contribution of minus 0.4 percentage point is excluded, the

rate turns out to be minus 0.1 percent. This number indicates that real private consumption would have been more or less unchanged if the irregular weather had not hit the economy.
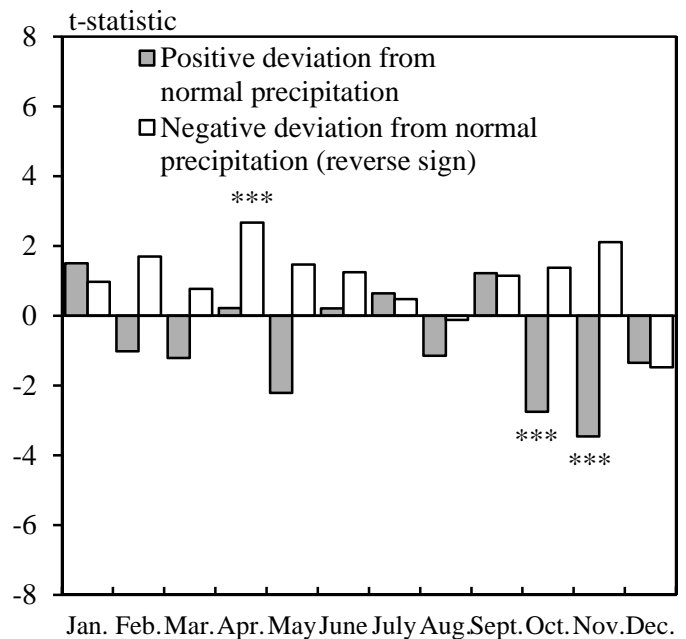
Weather Effects on Private Consumption

(1) Statistical Significance of the Parameter Estimates for Temperature and Precipitation Effects

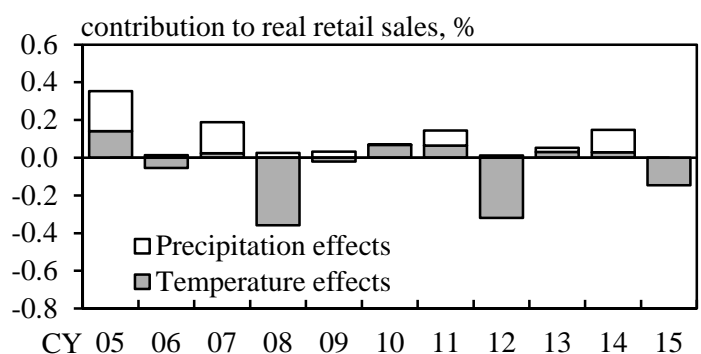(a) Temperature

(b) Precipitation

<Estimation Equation>
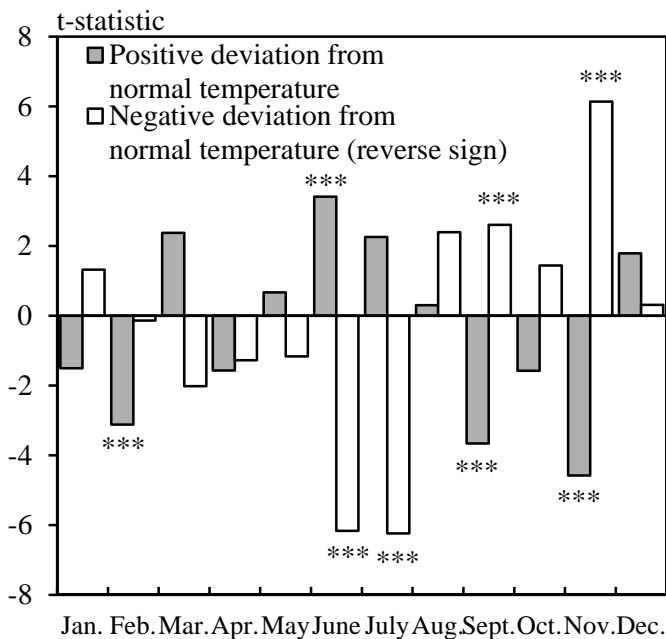
$\log(\text{Real retail sales}_{j,t})$

$= \rho \cdot \text{Lagged dependent variable}_{j,t-1}$

$+ \sum_{m=1}^{12} \beta_m^+ \cdot \text{Temperature}_{j,t}^+ + \sum_{m=1}^{12} \beta_m^- \cdot \text{Temperature}_{j,t}^-$

$+ \sum_{m=1}^{12} \gamma_m^+ \cdot \text{Precipitation}_{j,t}^+ + \sum_{m=1}^{12} \gamma_m^- \cdot \text{Precipitation}_{j,t}^-$
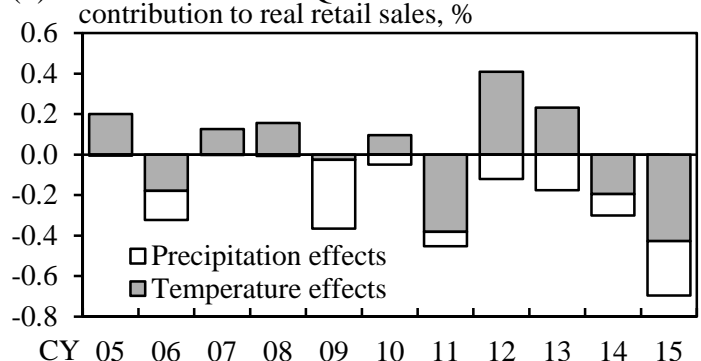
$+ A \cdot Z_t$

$\begin{bmatrix} \text{Constant, Regional fixed effects,} \\ \text{Real wages (m/m, Almon lag, \%),} \\ \text{Dummy variable for the consumption tax hikes,} \\ \text{Dummy variable for the Great East Japan Earthquake} \end{bmatrix} \in Z$

1. Subscript j denotes the region, t the time of observation, and m the month of the year.
2. + and - respectively denote a positive or negative deviation.
3. The following regional classification (9 regions) is used: Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa.
4. The estimation period is February 1991-December 2015.
5. Real retail sales are obtained by deflating nominal sales at department stores and supermarkets by the CPI for goods (excluding electricity, gas & water charges).

(2) Weather Effects in Past Years

(a) April-June Quarter

(b) October-December Quarter

Notes: 1. In the estimation in (1), deviations from the normal temperature are calculated using the 10-year average for the observation month to take the effects of global warming into account.

2. *** in (1) denotes statistical significance at the 1% level.

3. Figures in (2) are calculated using statistically significant (at the 1% level) parameters of temperature and precipitation in (1) and actual meteorological data.

Sources: Ministry of Economy, Trade and Industry; Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare; Japan Meteorological Agency.