(Box 7) The Mechanism of Adaptive Inflation Expectation Formation

Inflation expectations are formed through a combination of two components: a forward-looking component shaped by the price stability target set by the central bank, and a backward-looking, or adaptive, component reflecting the observed inflation rate. As shown in the Bank's Comprehensive Assessment in September 2016, the adaptive component plays a considerably larger role in Japan.

On this point, in order to gauge the quantitative impact of how the observed inflation rate affects inflation expectations in an adaptive manner, we estimate a vector auto-regression (VAR) model consisting of three variables: the observed inflation rate, short-term inflation expectations, and medium- to long-term inflation expectations. The estimation results are provided in Chart B7-1, where the response of short-term inflation expectations shows that the effects from the adaptive expectation formation process are maximized with a short time lag. Meanwhile, in terms of medium- to long-term inflation expectations, these effects are strengthened only after a considerable lag of about four to five quarters.
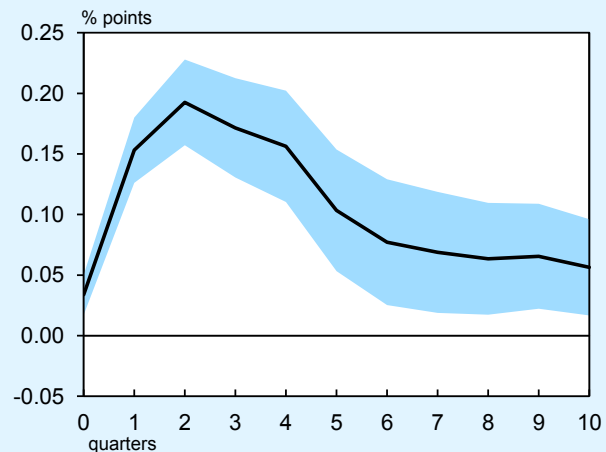
Note also that the estimated error bands of the impulse responses are rather wide, which indicates that the exact timing and quantitative impact of the adaptive expectation formation process are highly uncertain. This uncertainty goes in both directions, but when we consider the fact that the mindset and behavior based on the

Chart B7-1: Adaptive Inflation Expectation Formation
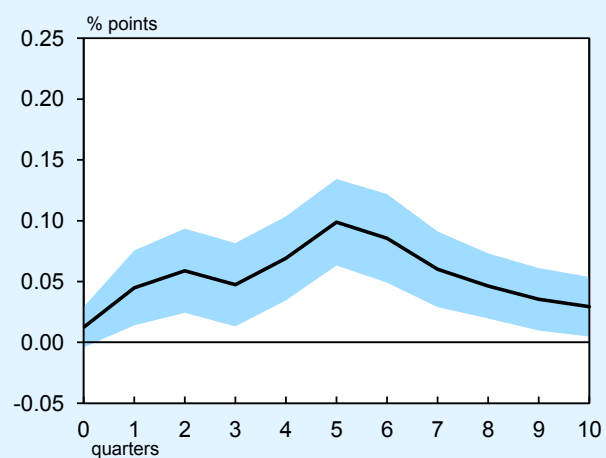
1. Model Specifications

Estimation Model: 3-variable VAR
 (a) CPI all items less fresh food
 (b) Short-term inflation expectations (1 year ahead)
 (c) Medium- to long-term inflation expectations (6 to 10 years ahead)
Shocks are identified by Cholesky decomposition in the above order.
Lags: 5 quarters.
Estimation period: 1990/Q1-2018/Q2.

2. Response of Short-Term Inflation Expectations to a +1 Percentage Point (Annualized) Shock to Observed Inflation

3. Response of Medium- to Long-Term Inflation Expectations to a +1 Percentage Point (Annualized) Shock to Observed Inflation

Sources: Ministry of Internal Affairs and Communications;
       Consensus Economics Inc., "Consensus Forecasts."
Notes: 1. CPI is quarter-on-quarter changes of seasonally adjusted series and is
          adjusted for changes in the consumption tax rate.
       2. Inflation expectations are from the "Consensus Forecasts."
       3. Shaded areas indicate ±1 standard error bands.

assumption that prices will not increase easily have been deeply entrenched in Japan, we need to pay more attention to the downside risk of rises in the observed inflation rate not leading to rises in inflation expectations.

We investigate this downside risk by estimating a regression model taking into account the possibility of medium- to long-term inflation expectations responding heterogeneously to positive or negative inflation. The model is estimated using data from 1998, which is the period when prices started to decline, and the results in Chart B7-2 indicate that the responses during this period to positive inflation are rather small compared to those to negative inflation.[53] Therefore, this suggests a tendency during this period as a whole of medium- to long-term inflation expectations being hesitant to rise with positive inflation and instead declining along with negative inflation.
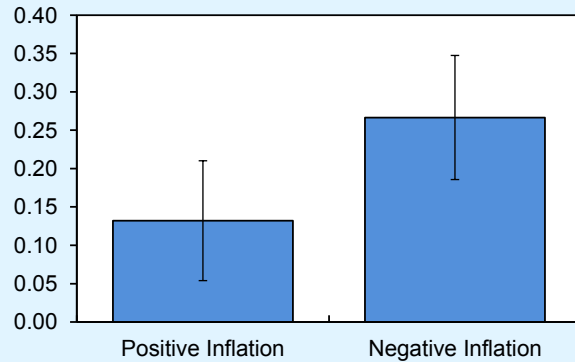
However, when we recursively change the sample period and estimate the model (rolling regressions), some noticeable features arise. First, since the introduction of QQE in 2013, the response to positive inflation has risen gradually. Second, and more recently, the response to negative inflation is declining gradually (Chart B7-3). Therefore, during this past couple of years, as Japan's economy has no longer been in deflation, the aforementioned heterogeneity in the responses of medium- to long-term inflation expectations observed in deflationary periods is diminishing.

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[53] Note that the difference between the coefficients on positive and negative inflation is not statistically significant.

Chart B7-2: Heterogeneity of Adaptive Expectation Formation

1. Estimation Model

Medium- to Long-Term Inflation Expectations$_t$

$= \alpha + \beta_1$ (Observed Inflation Rate)$_{t-1} \times D_{t-1, \text{ positive CPI inflation}}$

$+ \beta_2$ (Observed Inflation Rate)$_{t-1} \times (1- D_{t-1, \text{ positive CPI inflation}})$
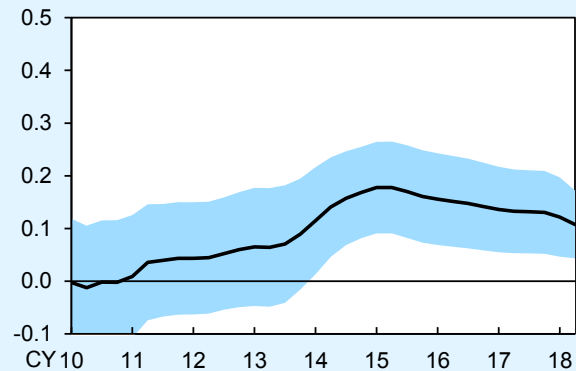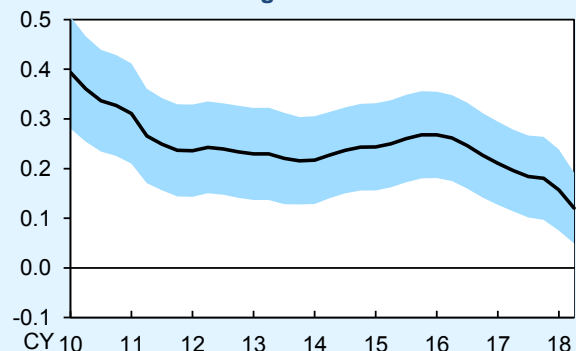
2. Estimation Results (β)

Sources: Ministry of Internal Affairs and Communications;
  Consensus Economics Inc., "Consensus Forecasts."
Notes: 1. Observed inflation rate is the year-on-year rate of change in the CPI less fresh food. Medium- to long-term inflation expectations are from the "Consensus Forecasts" (6 to 10 years ahead). The dummy variable for positive CPI inflation takes the value of 1 if the year-on-year rate of change in the CPI is positive and 0 otherwise.
  2. Estimation period is 1998/Q1-2018/Q2.
  3. The bands indicate ±1 standard errors of the estimated coefficients.

Chart B7-3: Changes to Coefficients on the Observed Inflation Rate

1. Coefficients on Positive CPI Inflation

2. Coefficients on Negative CPI Inflation

Sources: Ministry of Internal Affairs and Communications;
  Consensus Economics Inc., "Consensus Forecasts."
Notes: 1. Figures indicate the estimated coefficients from the 15-year rolling regression using samples from 1990/Q1 to 2018/Q2.
  2. The estimated model is the same as in the previous chart.
  3. Shaded areas indicate ±1 standard error bands. The horizontal axis indicates end points of each estimation.

Considering the above observations, as further price rises come to be observed widely, this likely will lead to a gradual rise in medium- to long-term inflation expectations through the adaptive inflation expectation formation mechanism.