

July 31, 2018
Bank of Japan

Outlook for Economic Activity and Prices (July 2018)

-- Analysis on Wages and Prices* --

- (1) The Recent Increase in Labor Supply and Wage Developments
- (2) Households' Tolerance of Price Rises
- (3) Firms' Cautious Price-Setting Stance
- (4) Recent Efforts by Firms to Raise Productivity
- (5) Intensifying Competition and Sectoral Shocks
- (6) Developments in Administered Prices and Housing Rent
- (7) The Mechanism of Adaptive Inflation Expectation Formation

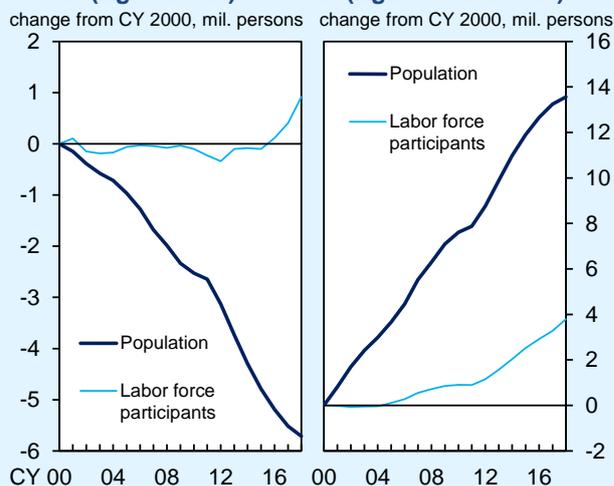
* This shows a series of analyses that was conducted in order to examine wage and price developments in deciding on the text of "The Bank's View" of the *Outlook for Economic Activity and Prices* (Outlook Report) at the Monetary Policy Meeting held on July 30 and 31, 2018. It will be presented as Boxes in the full text of the Outlook Report to be released at 2:00 p.m. Japan Standard Time on August 1, 2018.

(Analysis 1) The Recent Increase in Labor Supply and Wage Developments

Relative to the heightening degree of serious labor shortage, nominal wages have been sluggish. Basically, the reason for this is that, under Japan's labor market structure, which is characterized by different wage-setting mechanisms for regular and non-regular employees, the increase in wages of regular employees has been remarkably sluggish.¹ Regular employees tend to place priority on the long-term stability of employment over wage increases, while firms are maintaining their cautious wage-setting stance in reflection of an insufficient rise in medium- to long-term growth expectations. As an additional factor, this analysis examines the effects of the labor supply of women and seniors.

With labor shortage intensifying recently, the pace of increase in the labor force participation rate, especially among women and seniors, is accelerating. A closer look shows that, even though the population of women (aged 15-64) is decreasing, the number of those in the labor force is increasing, partly due to government initiatives to improve the work environment for women (Chart B1-1[a]).² In addition, while the number of

Chart B1-1: Labor Force Participants
(a) Women (Aged 15-64) (b) Seniors (Aged 65 and over)



Source: Ministry of Internal Affairs and Communications.
Note: Figures for 2018 are January-May averages on a seasonally adjusted basis.

Chart B1-2: Wage Elasticity of Labor Supply (Part-Time Employees)

Estimation Results

	Women aged 15-64	Men aged 15-64	Seniors aged 65 and over
Wage	0.40 *** <0.11>	0.27 *** <0.07>	0.56 *** <0.12>
Adj. R ²	0.96	0.94	0.97
Number of observations	6,580	6,580	1,316

Estimation period: CY 2004-2017.
The estimation is based on the prefecture-level panel data. The figures in brackets in the table are standard errors.
*** denotes statistical significance at the 1% level.

Sources: Ministry of Health, Labour and Welfare; Ministry of Internal Affairs and Communications.

Notes: 1. The dependent variable is the log of the number of part-time employees.
2. "Wage" is the log of the hourly wage of part-time employees.
3. In the estimation, the CPI (all items less fresh food), the unemployment rate, the ratio of the population aged 65 and over (only the estimation for "Seniors"), and dummy variables (for the prefecture, the year, and, in the estimations for "Men" and "Women," individuals' age) are included as control variables.

¹ For features of Japan's labor market and the sluggishness in wages of regular employees due to those features, see Box 2 in the July 2017 Outlook Report.

² For firms' efforts to promote the empowerment of women and seniors, see the annex paper to the *Regional Economic Report*, "Kaku chiiki ni okeru jyosei no katsuyaku suishin ni muketa kigyō tō no torikumi" [Firms' initiatives toward promoting women's empowerment in each region] released in June 2017 (available only in Japanese). Meanwhile, for an analysis of the reasons, including government initiatives, for the increase in women in employment, especially since 2012, see "The Recent Increase in Dual-Income Households and Its Impact on Consumption Expenditure," Bank of Japan Review Series (2017-E-7).

women and the ratio of employed seniors (Chart B1-6). The estimation results indicate that the increase in the ratio of employed women and of employed seniors pushes down the growth rate of total cash earnings in a statistically significant manner. The likely reason, as we have indicated, is the high wage elasticity of the labor supply of women and seniors.⁴

Chart B1-6: Impact of Labor Force Participation on Wages

Estimation Results

	Total cash earnings, y/y % chg.		
Unemployment rate, %	-0.76 *** <0.14>	-1.01 *** <0.14>	-0.79 *** <0.14>
CPI (less fresh food) y/y % chg.	0.49 *** <0.16>	0.60 *** <0.17>	0.49 *** <0.16>
Ratio of employed women y/y % points	-0.17 *** <0.06>		
Ratio of employed seniors y/y % points		-2.61 *** <0.39>	
Ratio of employed women and seniors y/y % points			-0.36 *** <0.11>
Adj. R ²	0.11	0.22	0.13
Number of observations	423	423	423

Estimation period: CY 2009-2017. Estimation method: Fixed effect model using the prefecture-level panel data. The figures in brackets in the table are standard errors. *** denotes statistical significance at the 1% level.

Sources: Ministry of Health, Labour and Welfare; Ministry of Internal Affairs and Communications.

Note: The ratios of employed persons are the share of employed persons in the corresponding population.

⁴ An additional reason is likely to be the composition effect: since the wage level of these groups is lower than that of men, an increase in the share of women and seniors in the labor force overall will push down the average wage.

(Analysis 2) Households' Tolerance of Price Rises

In order for inflation to rise moderately in a stable manner, it is essential to create an environment in which people accept price rises to some extent. When households' tolerance of price rises -- hereafter households' tolerance -- is low, a rise in inflation could make consumers' attitudes toward spending defensive, and as a result hinder the positive feedback between improvements in economic conditions and inflation.

On this point, we take "comments on the rise in prices" from the *Opinion Survey on the General Public's Views and Behavior* as a measure for households' tolerance. Chart B2-1 shows that, following the introduction of QQE in 2013, the level of households' tolerance shifted upward in a favorable direction compared to past levels. However, it has not maintained its high level in a stable manner so far, as it declined temporarily in the second half of 2014 to 2015 and more recently declined slightly once again in late 2017.

We investigate the background of these developments by working with individual respondents' data obtained in the above survey and decompose changes in households' tolerance into factors such as households' perceived inflation and its outlook, as well as views on employment, per household income (wages), economic conditions, and their outlook. The results are shown in Chart B2-1, which indicates that sharp rises in households' perceived inflation and its outlook put downward pressure on their tolerance. Conversely,

Chart B2-1: Households' Tolerance of Price Rises

1. Estimation Model Specification

(Ordered Probit Model)

Dependent variable:

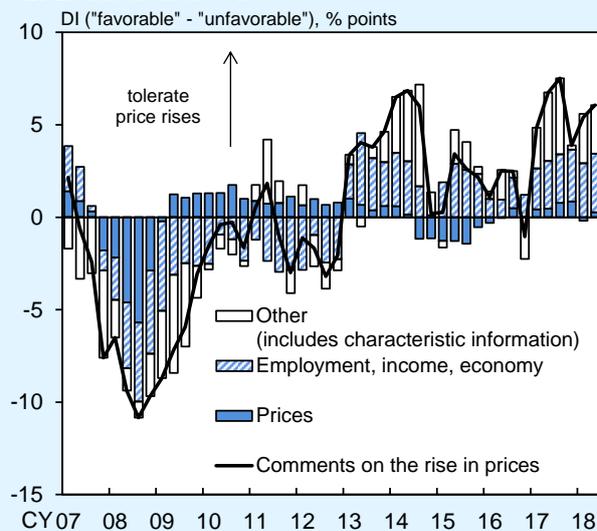
Opinion Survey on the General Public's Views and Behavior
"Comments on the rise in prices"

Explanatory variable:

- | | | |
|---|---|-----------------------------------|
| (1) Perception of the present price levels | } | Prices |
| (2) Outlook for price levels one year from now | | |
| (3) Outlook for price levels over the next five years | | |
| (4) Employment and working conditions | } | Employment,
income,
economy |
| (5) Present income | | |
| (6) Income one year from now | | |
| (7) Present economic conditions | | |
| (8) Economic conditions one year from now | | |

Note: Gender, level of income, and age are also controlled for.

2. Estimation Results



Source: Bank of Japan.

- Notes: 1. Comments on the rise in prices are chosen among three alternatives: "rather favorable," "difficult to say," and "rather unfavorable."
2. Estimation is done using effective samples in which all the relevant questions for the estimation were answered.
3. Figures show deviations from the displayed period average.

improvements in households' views on employment, wages, economic conditions, and their outlook drive households' tolerance in a favorable direction. Therefore, in order for households to be more tolerant of price rises, it is necessary to avoid sharp rises in inflation and promote improvements in the employment and income situation, such as wages, as well as growth expectations of the economy.

These tendencies also can be confirmed using the newly generated long historical data.⁵ On inspection, the effects of inflation on households' tolerance seem to change during different phases. In this regard, we estimate a regime-switching model where households' tolerance shifts between an "easy to rise" regime and an "easy to decline" regime depending on the level of real wage growth, which is defined as the difference between wage growth and CPI inflation. The estimation results in Chart B2-2 show that when real wage growth is low, the probability of being in the easy to decline regime is high. In other words, when nominal wage growth is lower than CPI inflation, households tend to not accept price rises.

These findings suggest that households' tolerance depends not only on price developments, but largely on the perceived state of current employment and income situations, such as wages, as well as their outlook. Going

Chart B2-2: Households' Tolerance of Price Rises as well as Wages and Inflation

1. Estimation Model and Results

(Regime Switching Model)

Comments on the rise in prices = constant + coefficient × CPI inflation
 + coefficient × wage growth
 + coefficient × QQE dummy variable

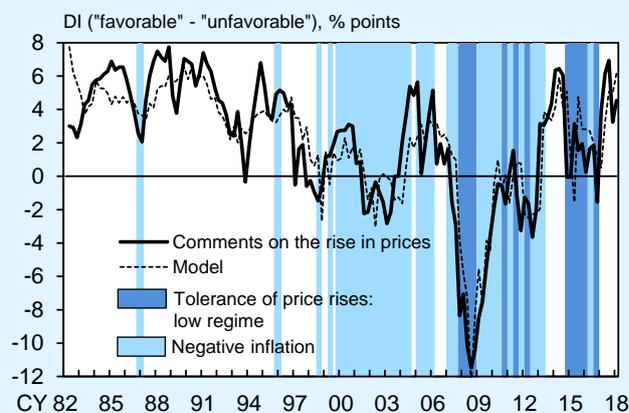
(a) Comments on the rise in prices are taken from the *Opinion Survey on the General Public's Views and Behavior* for 2004/Q4 onward. Periods prior to this are extrapolated using its relations with the overall livelihood DI series in the *Consumer Confidence Survey*, which shows a close resemblance (correlation between the two series is 0.76).

(b) Regimes switch between two states, according to the level of real wage growth.

	Tolerance of price rises: high regime	Tolerance of price rises: low regime
constant	2.09 *** (0.30)	-1.47 *** (0.41)
CPI inflation (y/y % chg. >0)	0.04 (0.18)	-4.87 *** (0.74)
CPI inflation (y/y % chg. <0)	0.04 (0.43)	
Wage growth (y/y % chg.)	0.92 *** (0.11)	
QQE dummy (2013/Q2 onward =1)	2.43 *** (0.44)	

Estimation period: 1982/Q2 to 2018/Q1. () indicates standard errors. *** denotes statistical significance at the 1 percent level.

2. Estimation Results



Sources: Bank of Japan; Ministry of Health, Labour and Welfare; Ministry of Internal Affairs and Communications; Cabinet Office.

Notes: 1. Dark shaded areas indicate periods where the probability of the low tolerance regime exceeds 50 percent and the annual CPI inflation rate is positive. Light shaded areas indicate periods where the annual CPI inflation rate is negative. Comments on the rise in prices are normalized to be zero at the average from 2004/Q4.
 2. Definition of wage growth is total cash earnings and that of CPI inflation is CPI all items (adjusted for changes in the consumption tax rate). Real wage growth is defined as the difference between wage growth and CPI inflation. We take the 8-quarter backward moving average of quarter-on-quarter real wage growth as a determinant of regime probabilities.

⁵ The question "comments on the rise in prices" has been included in the *Opinion Survey on the General Public's Views and Behavior* since the June 2004 survey. In the above analysis, we extend this series by using its relation to the overall livelihood DI series in the *Consumer Confidence Survey* (Cabinet Office), which tends to show a close resemblance.

forward, as factors suppressing wage growth dissipate and the growth potential of the economy as a whole strengthens with labor market conditions continuing to tighten, households' tolerance of price rises is expected to gradually increase.

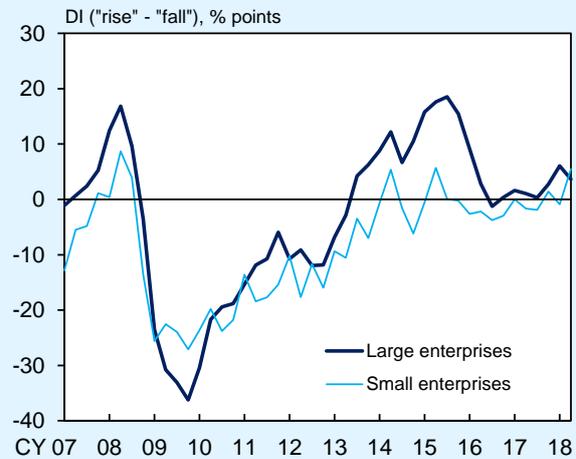
(Analysis 3) Firms' Cautious Price-Setting Stance

Even though input prices have been rising and labor costs have been increasing moderately but steadily, the rate of increase in the CPI has remained relatively moderate. This is likely because, in a situation where households' tolerance toward price rises has not been increasing easily (Analysis 2), firms are maintaining their cautious stance toward raising prices for fear of losing customers, mainly in sectors related to consumption.

In fact, the composite output prices DI consisting of "retailing," "services for individuals," and "accommodations, eating and drinking services," which are closely linked to household consumption, has been more or less flat over the past few years (Chart B3-1). Partly against this background, looking at a histogram depicting year-on-year rates of change in the prices of individual items making up the CPI shows that the mode continues to be at 0 percent (Chart B3-2). This differs from the United States and Germany, suggesting that the price-setting stance of Japanese firms remains cautious (Chart B3-3).

Why is firms' price-setting stance so cautious? Looking at the results of a survey of firms conducted in 2013, the reasons why firms do not pass on cost increases to sales prices include that they put priority on their long-term relationships with business partners and consumers, that competitors are not raising prices, and their fear that doing so would lead to a reduction in sales volume (Chart B3-4). Similar

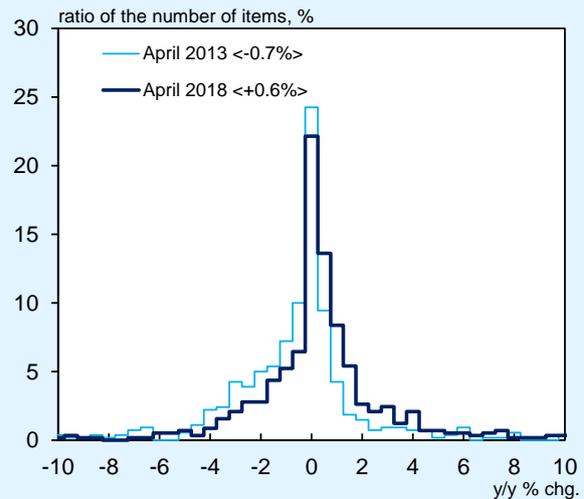
Chart B3-1: Output Prices in Consumption-Related Sectors



Source: Bank of Japan.

Note: Based on the *Tankan*. Calculated as the weighted average of the DI for changes in output prices in "retailing," "services for individuals," and "accommodations, eating & drinking services." The number of reporting enterprises is used as weights.

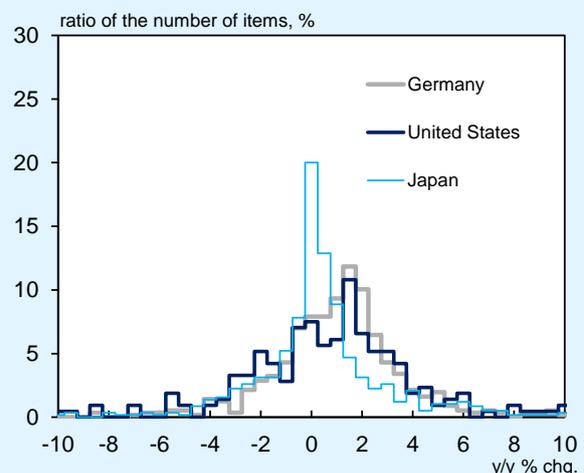
Chart B3-2: Histogram (CPI all items)



Source: Ministry of Internal Affairs and Communications.

Note: Figures in angular brackets show year-on-year rates of change in the CPI (all items).

Chart B3-3: Comparison of Japan, the U.S., and Germany (March 2018)



Sources: Ministry of Internal Affairs and Communications; BLS; Destatis.

views were voiced in interviews with firms recently conducted by the Bank's Head Office, branches, and local offices, indicating that many firms continue to be cautious about raising their prices (Chart B3-5).

However, amid this situation, firms' stance seems to be shifting gradually toward further raising prices. In fact, the aforementioned output prices DI has been rising recently (Chart B3-1). Moreover, compared to 2013, the histogram of the rate of change in the prices of individual items has shifted to the right (Chart B3-2). Interviews with firms also indicate that there are a number of cases where firms successfully raised prices (Chart B3-5).

Chart B3-4: Reasons for Not Passing On Cost Increases to Sales Prices



Source: Cabinet Office (2013), "Annual Report on the Japanese Economy and Public Finance 2013."
 Note: Based on a survey of 3,030 listed and 2,970 non-listed firms conducted by the Cabinet Office (2013).

Chart B3-5: Interview Responses by Firms (The Bank's Regional Economic Report)

- Since competitors have recently intensified their price-cutting strategies, we may also cut sales prices further in the future (a supermarket in Sendai).
- Since drugstores are expanding their lineup of food items, competition in the retail sector is intensifying. As a result, our sales are not good and it is difficult to raise sales prices (a supermarket in Nagoya).
- Consumers have a deep-rooted cost-saving mentality and we are losing customers to low-price retail businesses such as drugstores and online retailers (a supermarket in Kyoto).
- We are feeling the threat of other types of retail businesses that have intensified their price-cutting strategies at the expense of profits, and thus we have cut the sales prices of several hundred items, especially private-brand products (a supermarket in Hiroshima).
- With the number of dual-income households increasing, the demand for ready-made meals is growing as households need to save time on domestic chores. Against this background, we have raised our sales prices by about 10 percent and revised our selection of products, mainly of box meals and delicatessens. Our sales have remained good even after the price increases (a supermarket in Nagasaki).
- Given the rising cost of food ingredients such as beef and the increase in personnel expenses both for full-time and part-time workers, we have raised sales prices this year. Due to the firm demand for dining-out services, however, the number of customers has not changed very much, and our sales have increased (an eating/drinking establishment in Osaka).
- Since the occupancy rate of our hotel has remained high due to an increase in the number of foreign guests, we have gradually raised the rates we charge (a hotel in Okayama).

Source: Bank of Japan.
 Notes: 1. Extracted from the July 2018 *Regional Economic Report*.
 2. The parentheses show the industry of the interviewee and the Bank branch.

(Analysis 4) Recent Efforts by Firms to Raise Productivity

With labor shortages becoming more acute, labor-intensive sectors such as "retailing" and "accommodations, eating and drinking services" in particular face upward pressure on personnel expenses. Nevertheless, firms have maintained their cautious stance toward raising prices and increases in sales prices have been moderate (Analysis 3).

However, if firms simply do not raise prices, this will squeeze their profits and, in some cases, may lead them to make losses. Therefore, firms have been making efforts to absorb upward pressure of costs on prices by raising productivity through labor-saving and efficiency-improving investment, making use of the progress in digital technology in recent years and streamlining existing business processes.⁶ In fact, in sectors such as "construction," "retailing," and "accommodations, eating and drinking services," where labor shortage is especially acute, software investment has increased greatly (Chart B4-1).

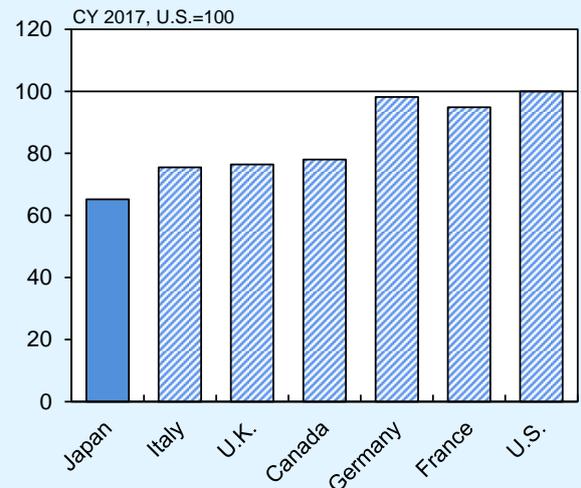
Why do firms prioritize raising productivity rather than prices? One reason is that the productivity of Japanese firms is relatively low and there is large room to raise productivity, mainly in the nonmanufacturing sector. In fact, Japan's labor

Chart B4-1: Software Investment (*Tankan*)



Source: Bank of Japan.
Note: Figures up through fiscal 2017 are actual results. Figures for fiscal 2018 are forecasts from the June 2018 survey.

Chart B4-2: International Comparison of Labor Productivity: Level

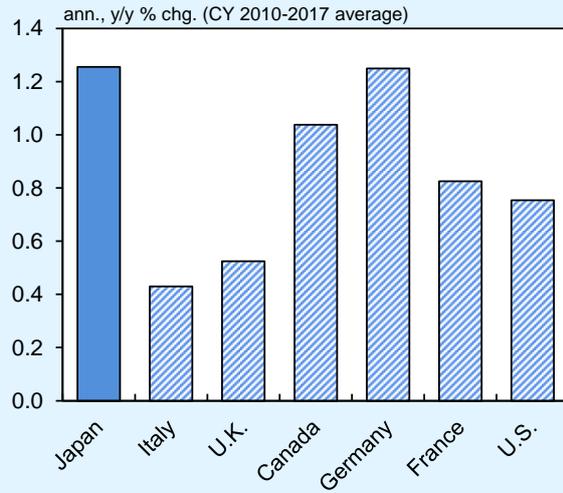


Source: Conference Board.
Note: Figures are real labor productivity per hour denominated by PPP exchange rates.

⁶ Regarding the fact that firms are absorbing upward pressure on prices by raising labor productivity, see Box 3 in the July 2017 Outlook Report and the annex paper to the *Regional Economic Report*, "Hi seizōgyō o chūshin to shita rōdō seisansei kōjyō ni muketa torikumi" [Efforts toward improving labor productivity in mainly the nonmanufacturing sector] released in December 2017 (available only in Japanese). Judging from the real wage gap, it appears that the situation described in these reports still exists.

productivity remains at only 60 to 70 percent of the U.S. level (Chart B4-2). Partly because firms accelerated their efforts to raise productivity in response to acute labor shortage -- in a situation where room for productivity improvements remained large -- productivity growth in Japan in the 2010s was the highest among the G7 economies (Chart B4-3).

Chart B4-3: International Comparison of Labor Productivity: Growth Rate



Source: Conference Board.
Note: Figures are growth rates of real labor productivity per hour.

(Analysis 5) Intensifying Competition and Sectoral Shocks

In theory, the output gap and inflation expectations are two important factors that determine general price inflation. In practice, however, it is also affected by sectoral shocks. A typical example of a sectoral shock is the reduction in mobile phone-related prices due to the spread of MVNOs (Mobile Virtual Network Operators).⁷ In addition, the price-cutting strategies of mainly supermarkets, which are facing competition with other types of retail businesses, also can be regarded as a sectoral shock.⁸

Prices of and charges for mobile phones dropped substantially last year as competition among mobile phone carriers intensified, partly reflecting the spread of MVNOs. Although the year-on-year rate of change in mobile phone prices has returned to around 0 percent recently, mobile phone charges continue to push down prices (Charts B5-1 and B5-2).⁹

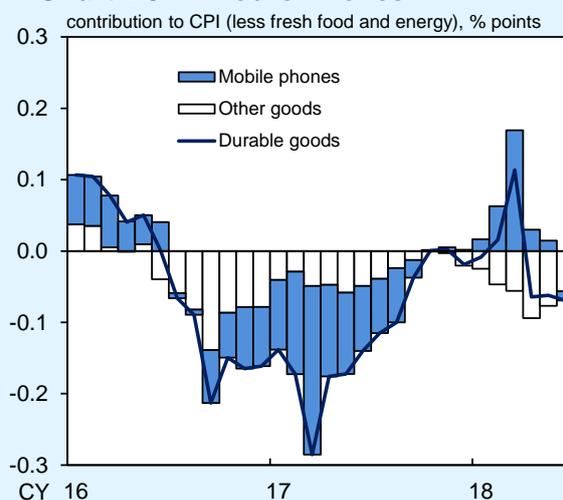
Looking at the Nikkei CPINow and the SRI-Hitotsubashi Unit Value Price Index, which are indexes aggregated mainly from supermarket

⁷ For details on the relationship between developments in the mobile phone market and the CPI, see also Box 4 in the April 2017 Outlook Report.

⁸ These examples can be interpreted as the inevitable adjustment in relative prices in response to a change in the competitive environment and also as supply shocks resulting from the rise of new businesses.

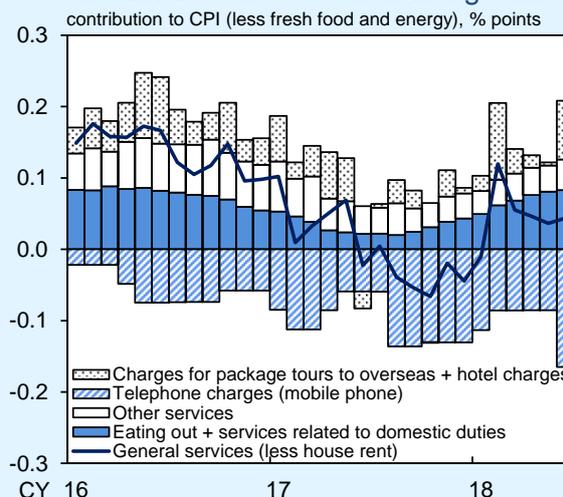
⁹ Meanwhile, looking at developments in general services (less house rent) -- excluding charges for mobile phone services -- the rate of increase has accelerated recently, with fluctuations resulting from charges for overseas package tours and hotel charges smoothed out.

Chart B5-1: Mobile Phones



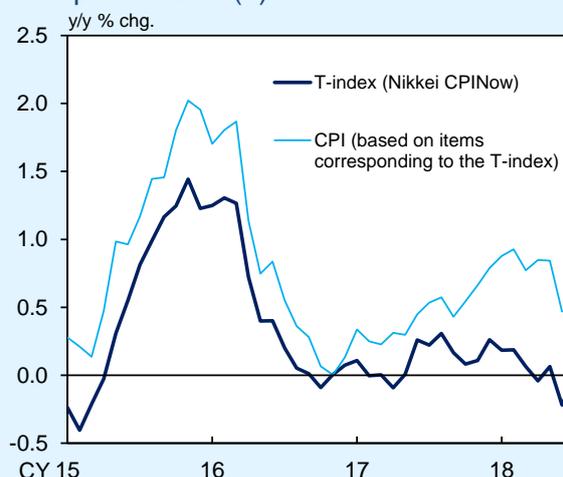
Source: Ministry of Internal Affairs and Communications.

Chart B5-2: Mobile Phone Charges



Source: Ministry of Internal Affairs and Communications.

Chart B5-3: Sales Price Changes in Supermarkets (1)



Source: NOWCAST, Inc.

Note: Figures are adjusted for changes in the consumption tax rate.

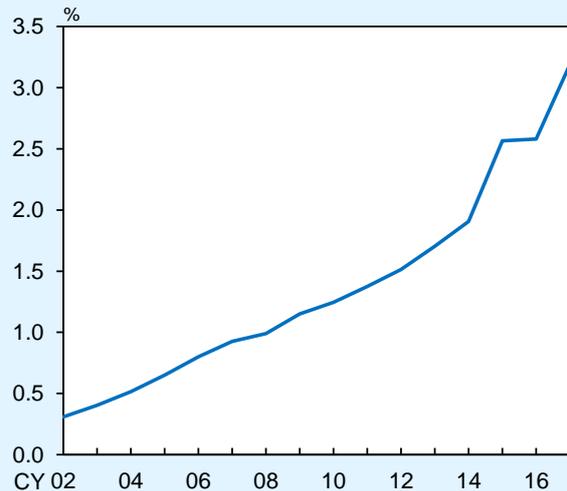
point-of-sales data, in order to examine developments in sales prices at supermarkets, the rates of increase have clearly slowed in the past year or so (Charts B5-3 and B5-4). Such relatively weak prices are likely due to the intensifying competition with online retailers and drugstores (Chart B5-5).¹⁰

Chart B5-4: Sales Price Changes in Supermarkets (2)



Sources: Research Center for Economic and Social Risks, Hitotsubashi University; Ministry of Internal Affairs and Communications.
 Note: Figures are adjusted for changes in the consumption tax rate.

Chart B5-5: Online-Shopping Ratio to Total Expenditure



Source: Ministry of Internal Affairs and Communications.
 Note: Figures are calculated using the "total expenditure on goods and services ordered over the Internet" from the "Survey of Household Economy" and "consumption expenditures" from the "Family Income and Expenditure Survey."

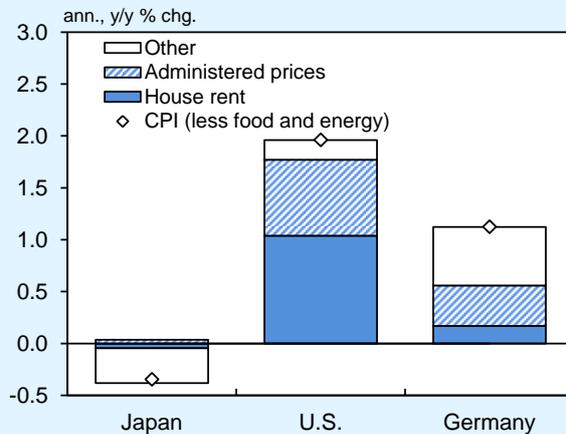
¹⁰ For details on how the rapid expansion of online shopping has exerted downward pressure on prices in Japan through competition with existing retailers such as supermarkets, see "The Effects of the Expansion of Online Shopping on Prices," Bank of Japan Review Series (2018-J-5) (available only in Japanese).

(Analysis 6) Developments in Administered Prices and Housing Rent

Comparing the year-on-year rates of change in the CPI excluding food and energy for fiscal 2017 in Japan, the United States, and Germany shows that a large contributing factor to the fact that Japan had the lowest inflation rate was the low rate of increase in administered prices and housing rent (Charts B6-2 and B6-3). The fact that the rates of increase in administered prices and housing rent in Japan are relatively low by international comparison also can be observed over the long term (Chart B6-1). Incidentally, when imputed rent is included, the total share of housing rent and administered prices accounts for almost 50 percent of the CPI excluding food and energy, and thus developments in these prices have a major impact on the CPI.

There are various specific factors underlying the low rates of increase in administered prices and housing rent. For instance, administered prices do not sufficiently reflect operating expenses and depreciation costs of equipment partly because government subsidies for supplementing revenues are provided to public enterprises.¹¹ Housing rent has been influenced by an increase in construction starts of housing for rent in recent years, partly due to tax saving. Rent figures of housing for rent are also applied to imputed rent of owned houses, of which supply has not necessarily increased in recent years. In addition, how the effects of deterioration of housing for rent

Chart B6-1: FY 2001-2016 Average
<Contribution of Each Component>



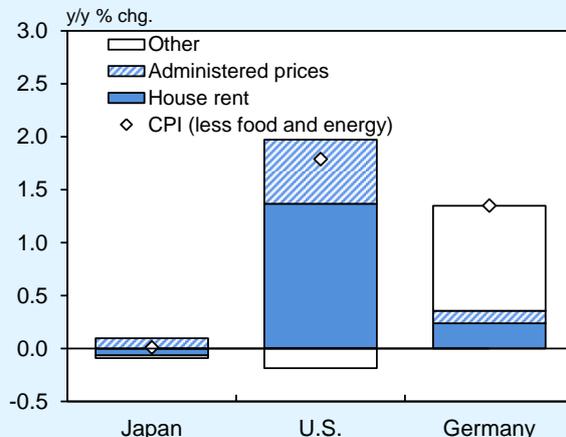
Sources: Ministry of Internal Affairs and Communications; Haver; Dexter, A., M. Levi, and B. Nault (2002), "Sticky Prices: The Impact of Regulation," *Journal of Monetary Economics*.

Notes: 1. Administered prices in the U.S. consist of items classified as "regulated" by Dexter et al. (2002).

2. Administered prices in Germany are those in the Harmonized Index of Consumer Prices (HICP).

3. Figures for Japan are adjusted for changes in the consumption tax rate.

Chart B6-2: FY 2017
<Contribution of Each Component>



Sources: Ministry of Internal Affairs and Communications; Haver; Dexter, A., M. Levi, and B. Nault (2002), "Sticky Prices: The Impact of Regulation," *Journal of Monetary Economics*.

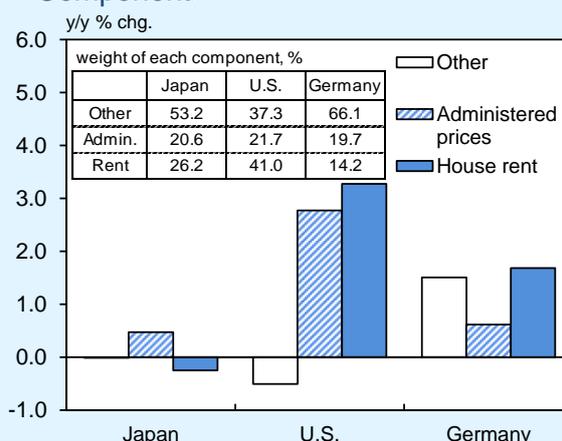
Note: The definitions of administered prices in the U.S. and Germany are the same as in Chart B6-1.

¹¹ Also see Box 4 in the July 2016 Outlook Report on various idiosyncratic factors behind the sluggish rise in administered prices and housing rent in Japan compared to in Europe and the United States.

due to aging should be reflected in the CPI has been pointed out as an issue.¹²

Another factor is that households are reluctant to accept rises in housing rent and administered prices given the low actual inflation rate and inflation expectations, since developments in general prices are often used for reference in negotiations to raise housing rent and in processes to set administered prices.¹³

Chart B6-3: FY 2017 <% Chg. of Each Component>



Sources: Ministry of Internal Affairs and Communications; Haver; Dexter, A., M. Levi, and B. Nault (2002), "Sticky Prices: The Impact of Regulation," *Journal of Monetary Economics*.

Notes: 1. The definitions of administered prices in the U.S. and Germany are the same as in Chart B6-1.
2. The weight of each component is the share in the CPI (less food and energy).

¹² The Ministry of Internal Affairs and Communications has been examining quality adjustments for housing rent in the CPI with the aim of releasing a reference index at the next rebasing of price indexes to the base year 2020. Based on the paper "Changes in Rent of Rented Housing over Time -- A Study on the Quality Adjustment for House Rent in the CPI" released by the Price Statistics Office in the Statistics Bureau of the Ministry of Internal Affairs and Communications in July 2018 (available only in Japanese), the deterioration of housing for rent due to aging pushed down the CPI (all items) by 0.1 to 0.2 percentage point per year on average from 2014 to 2017.

¹³ Box 3 in the October 2015 Outlook Report shows that, while housing rent and administered prices respond little to changes in the output gap, they are significantly influenced by past inflation rates.

(Analysis 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.

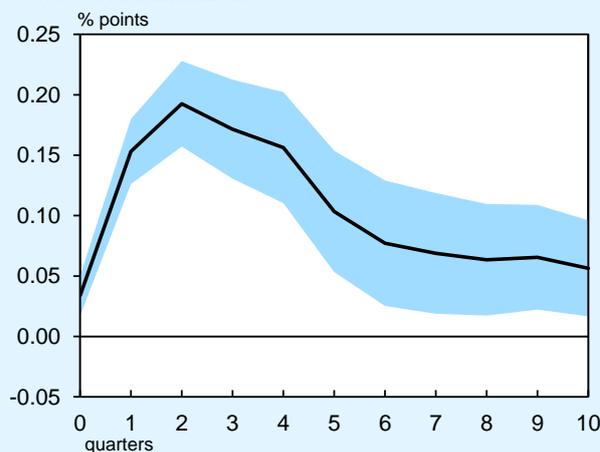
Note also that the estimated error bands of the impulse responses are rather wide, which indicates that the exact timing and quantitative impact of the adaptive expectation formation process are highly uncertain. This uncertainty goes in both directions, but when we consider the fact that the mindset and behavior based on the

Chart B7-1: Adaptive Inflation Expectation Formation

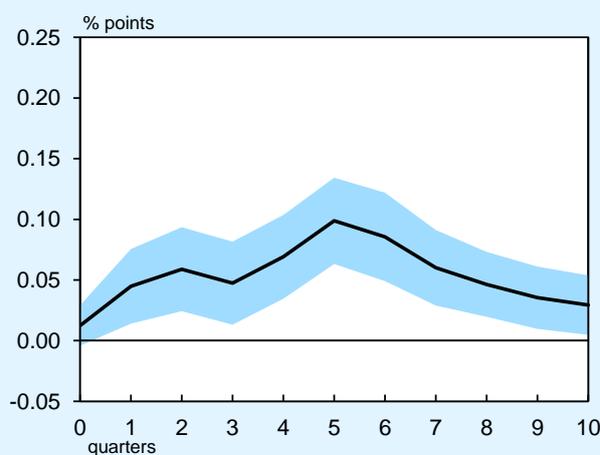
1. Model Specifications

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.¹⁴ 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.

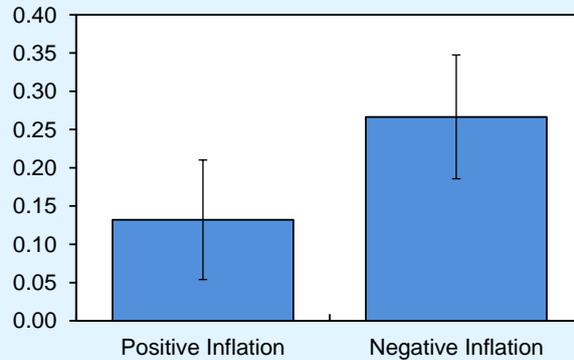
However, when we recursively change the sample period and estimate the model (rolling regressions), some noticeable features arise. First, since the introduction of QQE in 2013, the response to positive inflation has risen gradually. Second, and more recently, the response to negative inflation is declining 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.

Chart B7-2: Heterogeneity of Adaptive Expectation Formation

1. Estimation Model

$$\begin{aligned} & \text{Medium- to Long-Term Inflation Expectations}_t \\ &= \alpha + \beta_1 (\text{Observed Inflation Rate})_{t-1} \times D_{t-1, \text{ positive CPI inflation}} \\ & \quad + \beta_2 (\text{Observed Inflation Rate})_{t-1} \times (1 - D_{t-1, \text{ positive CPI inflation}}) \end{aligned}$$

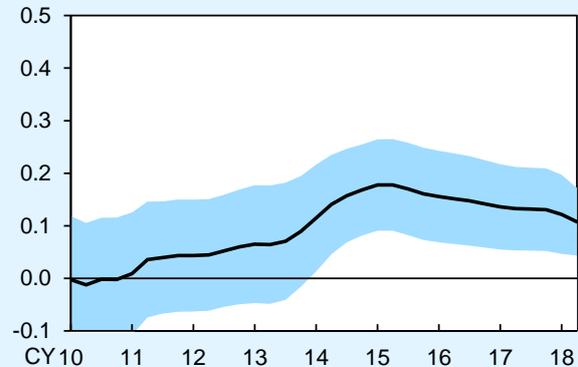
2. Estimation Results (β)



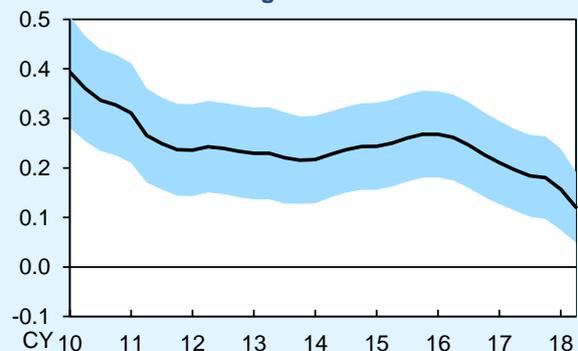
Sources: Ministry of Internal Affairs and Communications; Consensus Economics Inc., "Consensus Forecasts."
 Notes: 1. Observed inflation rate is the year-on-year rate of change in the CPI less fresh food. Medium- to long-term inflation expectations are from the "Consensus Forecasts" (6 to 10 years ahead). 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.

¹⁴ Note that the difference between the coefficients on positive and negative inflation is not statistically significant.

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.