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Inflation in Japan: Changes during the Pandemic and Issues for the Future*

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[Abstract]

As the impact of COVID-19 pandemic eased and economic activity resumed, prices have risen sharply in the U.S. and Europe, partly due to the impact of rising commodity prices. Although not to the same extent as the U.S. and Europe, in Japan inflation rates have also been rising, especially for goods prices. In order to further develop the discussion on the nature of these recent price developments in Japan and their outlook, this paper (1) summarizes the characteristics of inflation dynamics in Japan before the spread of COVID-19, mainly using the framework of the Phillips curve, (2) confirms the recent changes and characteristics of price developments, and (3) summarizes the issues for the future. Based on the fact-finding of this paper, we conclude it is important to accumulate analyses on the stickiness of service prices, nominal wage rigidity, and uncertainty in inflation expectations, which are characteristic of Japan, in order to further deepen the discussion on these recent price developments.

JEL Classifications: E30; E31; J30
Key words: Phillips curve, Cost push, Price rigidity, Inflation expectations, Wages

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1. Introduction

As the impact of the novel coronavirus (COVID-19 hereafter) pandemic eased and economic activity resumed, prices in the U.S. and Europe have risen sharply, also partly due to the effects of rising commodity prices associated with the situation in Ukraine. In Japan, too, the rate of price increases is clearly rising, although not to the same extent as the U.S. and Europe.

With the aim of further developing the discussion on the characteristics of these recent price developments in Japan and their outlook, this paper reiterates the nature of inflation dynamics in Japan before the spread of COVID-19, identifies recent changes and characteristics, and summarizes the issues of future price development.

The rest of this paper is organized as follows. In Section 2, as a starting point for the discussion, we summarize the characteristics of long-term price developments in Japan before the spread of COVID-19, contrasting with those in the U.S. and Europe, mainly using the Phillips curve framework. Section 3 summarizes the characteristics of recent price developments and discusses their impact on future consumer prices. In Section 4, we will examine the issues surrounding the stickiness of service prices, which is considered particularly important for achieving price stability on a sustainable basis—specifically, the underlying medium- to long-term inflation expectations and wage developments—in order to explore the implications for future price developments.

2. Inflation dynamics before the spread of COVID-19

(1) Price developments before COVID-19 and the Phillips curve

In this section, we reiterate price developments before the spread of COVID-19 from a somewhat longer term perspective.

First, looking at the inflation dynamics by goods and services in Japan in a long time series, we see that significant changes occurred from the end of 1990s to the early 2000s (Chart 1). Namely, average inflation rates of both goods and services have declined since this period. Looking more closely, we can confirm that while (1) goods prices rose at times in 2007-2008 as costs were passed on, (2) service prices remained sticky near zero percent and hardly changed at all. As service prices (which have a large item weight) have become sticky near zero percent, the median inflation rate (weighted by item weight) has also remained near zero percent.

Next, to confirm the relationship between these price developments and supply and demand conditions, the simple Phillips curve plotting the relationship between price developments and the supply and demand conditions implies that the slope of the curve has declined since the beginning of the 2000s, meaning that prices are less likely to move even when the output gap changes (Chart 2). Of course, to capture more precisely the effects of the change of supply and demand conditions on the change in inflation rates, it is preferable to see their relationship by controlling for the effects of medium- to- long-term inflation expectations and cost-push shocks. In fact, in the standard New Keynesian framework, the inflation rates (π_t) are assumed to be affected not only by the output gap (y_t) but also the medium- to long-term inflation expectations ($E_t[\pi_{t+\infty}]$) and cost-push shocks ($\tilde{\varepsilon}_t$) [1]. Keeping these points in mind, we measure the slope of the Phillips curve by two approaches.

$$\pi_t = \tilde{\kappa} y_t + E_t[\pi_{t+\infty}] + \tilde{\varepsilon}_t \tag{1}$$

The first approach is to estimate a VAR model which consists of inflation rates, the output gap, medium- to long-term inflation expectations (Consensus Forecast[2], 6-10 years ahead), and cost-push shocks (import prices in contract currency terms and the dollar-yen exchange rate). We estimate it using rolling sample windows to measure changes in the impulse responses of the inflation rates to a positive output gap shock. The estimation results (Chart 3) show that, for both goods and services, the impulse responses became smaller when the sample period included the late 1990s and early 2000s, suggesting that the slope of the Phillips curve declined and flattened at that time. Moreover, these results show that the impulse responses do not change significantly since early 2000s, implying that the Phillips curve has flattened reflecting the changes of economic conditions in late 1990s and the early 2000[3].

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[1] We can derive Equation (1) by solving forward the New Keynesian Phillips Curve ($\pi_t = \kappa y_t + \beta E_t[\pi_{t+1}] + \varepsilon_t$). See Hazell et al. (2022) for details.

[2] For 1989 and earlier, we use estimates from Hogen and Okuma (2018) because Consensus Forecast data do not exist.

[3] In detail, the Phillips curve appears to be flattening further since the beginning of 2020. This may be due to the behavior of consumers and firms during the outbreak of COVID-19. For example, while the number of infections increased, sales were not held as they usually would be and price declines were suppressed despite the slack in the economy. This may be because stores were trying to avoid crowds caused by holding sales or, it was difficult to attract customers through sales (consumers were increasingly inclined to finish shopping in a short period without looking for a cheaper store). However, these changes seem to be basically temporary under the spread of COVID-19, and are unlikely to indicate a further flattening of the Phillips curve, which will continue even after the impact of pandemic has subsided. On this point, see Bank of Japan (2022a).

The second approach is to use panel data to estimate the slope of the Phillips curve, controlling for the effect of medium- to long-term inflation expectations. Specifically, we present the results of Kishaba and Okuda (forthcoming), who applied the estimation framework of Hazell et al. (2022), which measured the slope of the Phillips curve using the U.S. state-level CPI, to Japanese data. They conducted the panel estimation of service prices (which differ across regions) by using prefecture-level CPI data. The estimation equation is as follows[4].

$$\pi_{i,t} = \alpha_i + \gamma_t + (\beta_1 + \beta_2 D_t) y_{i,t} + \varepsilon_{i,t}, \tag{2}$$

where i indicates the region (prefecture) and t the period. $\pi_{i,t}$ is the inflation rates in region i and $y_{i,t}$ a variable representing supply and demand conditions (active job openings-to-applicants ratio) of the region. α_i is the fixed effect of the region i and γ_t the time effect at period t. The coefficient $\beta_1 + \beta_2 D_t$ on the supply and demand conditions $y_{i,t}$ is the slope of the Phillips curve. To check whether the slope has changed around 2000, it includes the dummy variable D_t which takes one after January 2000 and zero before December 1999. Inflation expectations are controlled for by the time fixed effect as a common factor across regions[5], which makes it possible to set aside the effect of inflation expectations when measuring the slope of the Phillips curve. The estimation results show that the slopes $\beta_1 + \beta_2$ after January 2000 are smaller than that before (β_1), and the differences are statistically significant for almost all service categories (Chart 4). Thus, the decline in the slope of the Phillips curve for service prices since the early 2000s is also confirmed in the framework of the panel analysis.

(2) Background of the flattening of the Phillips curve

This flattening of the Phillips curve *before* COVID-19 has been described as a phenomenon common to advanced countries[6], and its background has been actively

[4] Hazell et al. (2022) and Kishaba and Okuda (forthcoming) also estimate a formulation that adds relative prices (CPI for each item divided by the CPI for all items) as an explanatory variable. However, since the qualitative implication remains the same, we present here the results for the case with relative prices excluded.

[5] Nishizaki and Watanabe (2000) point out that when estimating Phillips curves using prefecture-level panel data, the results differ significantly depending on whether inflation expectations are controlled for as a time effect or not. Kishaba and Okuda (forthcoming) confirm that inflation expectations for each prefecture generally vary similarly and can be regarded as part of the time effect (since the time effect includes various factors common to all prefectures, the time effect does not only represent the inflation expectations).

[6] Several studies cast doubt on the flattening of the Phillips curve: for example, Hazell et al. (2022)

studied. For example, many studies covering the U.S. and Europe point out the anchoring of inflation to inflation targets as the reason for the flattening (e.g., Del Negro et al. 2020; Bem et al. 2021; Bobeica et al. 2021). Forbes (2019) also points out that stronger trade relations and increased international competition due to globalization could also flatten the Phillips curve. There are many other studies which also indicate additional factors, such as the progress of digitalization and changes in the labor market. For example, the analysis of the ECB's strategy review in 2021 identified the possibility that a combination of these various factors may have led to the flattening of the Phillips curve (ECB 2021).

These conventional arguments in the U.S. and Europe also seem applicable to Japan in many respects. However, there are aspects of price developments in Japan that differ from those in the U.S. and Europe, and it is highly possible that the hypotheses originating overseas do not fully explain price developments in Japan. In particular, the increase in the rigidity of service prices since 2000, which as discussed earlier, is not as clear as that of the U.S. in Japan (Chart 5). Principal component analysis of consumer prices from various countries, including Japan, shows that while goods prices in Japan also tend to fluctuate under the influence of global factors (the first principal components), fluctuations in service prices are hardly explained by global factors, suggesting that Japan's unique circumstances could influence prices (Chart 6). In more detail, looking at the distribution of service prices in Japan by category (Chart 7), it has shifted to the left since the 2000s, with the inflation rates concentrated near zero percent. Also, the price revision rate, which is estimated by using the Retail Price Survey by item and city, shows a marked tendency for the distribution of services to be concentrated near zero percent after the beginning of the 2000s[7]. In this regard, Fuchi and Watanabe (2002) estimated the Phillips curve by industry and noted that the service industry has a longer period of price deferral than the manufacturing industry. Higo and Saita (2007), using the Retail Price Survey for the period 1989-2003, report that service price stickiness has increased significantly since the 1990s.

Although there has not been a consensus on the mechanisms by which price stickiness rises under low inflation environment in Japan, several hypotheses have been proposed. For example, it has been proposed that (1) under low inflation environment, price increases are hard for consumers to predict and thus makes them switch to other

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point out that the state-level data does not confirm the flattening of the Phillips curve in the U.S.

[7] Since only cases in which prices were revised are considered here, the price revision rate is never equal to zero percent. The fact that the price revision rate is concentrated around zero percent means that the range of price revisions is extremely small.

stores to buy items (kinked demand curves: Sirota 2015; Aoki et al. 2019), and (2) menu costs for price revisions are relatively large under low inflation environment, making it hard for firms to raise prices (Watanabe and Watanabe 2016; Levin and Yun 2007; Kaihatsu et al. 2022). Furthermore, in service industries, the stickiness of nominal wages also seems to play an important role, considering the fact that labor costs account for high percentage of costs (Chart 8). Many studies, such as Yamamoto and Kuroda (2017), point out that nominal wages in Japan are rigid both upward and downward, which may also affect the rigidity of service prices.

3. Price developments under COVID-19

(1) Recent price developments: comparison among Japan, the U.S. and Europe

In the previous section, we summarized the price developments in Japan before the spread of COVID-19, comparing them with those in the U.S. and Europe.

As we argued, prior to the spread of COVID-19, the flattening of the Phillips curve —the stickiness of prices—has attracted attention among academics and central banks in not only Japan, but also the U.S. and Europe. However, as the impact of COVID-19 has eased and economic activity resumed, the global environment for prices has been changing dramatically. The year-on-year inflation rate of the consumer price index in the U.S. and Europe is rising significantly, and in Japan, too. Though the increase is not as large as in the U.S. and Europe, it is still significant (Chart 9).

A breakdown of the inflation rates in Japan, the U.S., and Europe shows that energy and goods are rising due to the impact of globally common factors such as price hike in oil and other commodities and difficulties in the procurement of parts due to supply-chain disruptions. However, there are differences in the rate of increase in energy prices across regions due to differences in systems and the rates of increase in natural gas prices, which differ across regions. In addition, as Yagi et al. (2022) point out, the inflation rates of goods other than energy is also relatively limited in Japan due to (1) limited increases in logistics and labor costs in Japan so far and (2) a low pass-through rate of intermediate input costs to final products compared to the U.S. (although there are some signs that this rate is increasing in Japan as well). On the other hand, the inflation rates of service prices in Japan still remain low. Namely, signs of significant changes in price stickiness of services in Japan have not been confirmed clearly at this time.

(2) The effects of shocks on prices

How should we consider the recent increase in inflation rates? This depends on what we regard as the relevant background to the increase.

To further consider this point, based on the above argument, we first attempt to statistically examine how the three variables (the output gap, medium- to long-term inflation expectations, and cost-push shocks) affect inflation dynamics through two approaches. It should be noted, however, that most of the data in this analysis are those from before the spread of COVID-19 and cannot take into account the possibility that the economic structure may have changed due to the spread of COVID-19.

First, to see how long each shock affects consumer prices, we use the VAR model which Yagi et al. (2022) introduced to capture the pass-through of cost-push shocks. Specifically, we estimate the four-variate VAR model comprising CPI (all items less fresh food and energy, and temporary factors such as the effects of the reduction in mobile phone charges), the output gap and cost-push indexes (nominal effective exchange rates and the intermediate input cost index[8]), and then confirm impulse responses of CPI inflation to shocks of these variables. The sample period is 2002/1Q-2019/4Q.

According to the estimation results (Chart 10), among the cost-push shock indicators, the price-push effect of a shock to intermediate input costs increases peaks one quarter after the shock is given and soon decays, disappearing after about one year[9]. The impact of a yen's depreciation shock also decays relatively quickly. On the other hand, the price-push effect of a shock that improves the output gap persists for about two years. Thus, the effects of cost-push shocks such as commodity price hikes and yen depreciation on prices will converge in a relatively short period of time if the VAR is taken in line with the average relationship shown in the past. This may indicate that when cost increases occur without an improvement in the supply-demand balance in the economy, a mechanism is at work whereby households' real income declines, consumption is suppressed, and downward pressure is exerted on prices—if the output gap improves, the economy and prices will improve in a balanced manner. However, this estimation does not explicitly include medium- to long-term inflation expectations and may not fully capture the channels through which cost-push shocks affect medium- to long-term inflation expectations via real price increases.

Second, using the data of Consumer Price Index by item, we examine how many items experience price increases by each shock. We perform a regression analysis using

[8] For the intermediate cost input index, see Yagi et al. (2022), Bank of Japan (2021b, 2022b).

[9] Chart 10 plots the effect of pushing up prices at each point in time, rather than the cumulative impulse responses.

the following equation, bearing the Phillips curve in mind.

$$\pi_{i,t} = \beta_i^{(1)} y_{t-\ell_1} + \beta_i^{(2)} \pi_t^e + \beta_i^{(3)} ipi_{i,t-\ell_2} + \varepsilon_{i,t}, \tag{3}$$

where $\pi_{i,t}$ is the year-on-year change in the price of item i, y_t is the output gap, π_t^e is the medium- to long-term inflation expectations (Consensus Forecast, 6-10 years ahead)[10], and $ipi_{i,t}$ is the year-on-year rate of increase in import prices (yen basis) [11]. We excluded items categorized into fresh food and energy from the estimation. The estimated coefficients $\beta_i^{(1)}, \beta_i^{(2)}, \beta_i^{(3)}$ all depend on the item since we estimate the equation by item. The goal here is to investigate the change in the distribution of inflation rates given positive shocks to each explanatory variable. In the estimation, for each item, we adopt the specification with the largest coefficient of determination (adjusted R^2) among the combinations of (1) lag orders ℓ_1 and ℓ_2 (0-4 periods) and (2) import price index (one of "food and beverage," "petroleum and coal, etc.," "metals and similar products," "textiles," "wood, wood products and forest products," and "chemical products"). The sample period is 1983/Q1-2021/4Q.

First, looking at the impact of a cost-push shock (import price inflation shock) on prices (Chart 11(1)), for goods prices, there is a peak of the distribution on the right side (positive range) because the inflation rates for some items rise (such as food). On the other hand, there has been little change in service prices. In other words, the inflation driven by cost-push shocks is likely to be limited to a few items. Second, looking at the effect of a positive output gap shock (Chart 11(2)), we see that the distribution for the price of goods shifts toward the right, indicating that prices rise for a wider range of items than in the case of a cost-push shock. For service prices, on the other hand, price increases are still limited. This is consistent with the fact that service prices have been firmly sticking around zero percent since 2000, regardless of changes in supply and demand conditions, and that the Phillips curve has flattened. Finally, looking at the impact of a shock to medium- to long-term inflation expectations (Chart 11(3)), the distribution shifts to the right not only for goods but also for services. This can be interpreted as suggesting that if inflation expectations rise clearly, the strong stickiness of inflation rates for service prices near zero percent since the 2000s will decline.

In summary, the above results suggest that the recent price rises that are mainly due

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[10] Similarly to Section 2 we use estimates from Hogen and Okuma (2018) for 1989 and earlier.

[11] For notational simplicity, we include the constant term in the residual $\varepsilon_{i,t}$.

to the cost-push such as a surge in commodity prices and the yen's depreciation are unlikely to lead to sustainable price stability on their own. Looking ahead, however, if the output gap improves by the resumption of economic activity and other factors, prices are expected to rise for a wider range of items, accompanied by an improvement in economic activity. If firms change their stance toward changing their selling prices and medium- to long-term inflation expectations rise under these circumstances, prices may rise, including service prices, which have remained sticky under low inflation since the 2000s. As noted above, the inflation rates for many services in Japan remains low at present, but we need to keep a close eye on whether they will change.

4. Issues surrounding future price developments: the future of service price stickiness

The discussion so far has shown that (1) the rigidity of service prices has strengthened in Japan since the 2000s, and this is thought to have contributed to the low inflation rate relative to the U.S. and Europe; (2) this trend itself has not changed significantly during the recent global price hikes, including in Japan; and (3) (based on analysis of data from before COVID-19), the rise in medium- to long-term inflation expectations may affect a wide range of service prices.

In light of these points, it is thought that trends in medium- to long-term inflation expectations will be one of the key factors for achieving sustainable price stability in Japan. In addition, wage developments are likely to play an important role in the process of reflecting changes in medium- to long-term inflation expectations. Increases in nominal wages will affect service prices on the cost side and, through an improved household income situation, will help maintain a favorable economic environment even under moderate rise in inflation. Conversely, if nominal wages are suppressed while medium- to long-term inflation expectations rise, demand will be suppressed through lower expected household income and other factors, which will work to put downward pressure on prices, including service prices.

Based on these perspectives, we conclude with a brief review of the issues surrounding medium- to long-term inflation expectations and wages.

(1) Uncertainty of medium- to long-term inflation expectations

In Japan, inflation expectation has a strong adaptive nature affected by actual inflation, compared to the U.S. and Europe. Recent figures of medium- to long-term inflation expectations for firms and households have been rising along with a relatively large increase in actual inflation (Chart 12). However, the mechanisms underlying medium- to long-term inflation expectations in Japan are extremely complex, as pointed out by Bank of Japan (2021a) and others. Partly because the view and practice in Japanese society that prices are unlikely to rise over the long term has become entrenched, the degree and lags of the effect of an increase in actual inflation on medium- to long-term inflation expectations is highly uncertain (Bank of Japan 2016, etc.).

Macroeconomic theory usually assumes the "Full Information and Rational Expectation (FIRE) hypothesis." Recently, however, the validity of this hypothesis has been rejected by various empirical studies based on survey data of firms and households in many countries including Japan[12]. Accordingly, several alternative hypotheses to FIRE have been proposed, such as "rational inattention hypothesis" and "sticky information hypothesis" (Maćkowiak and Wiederholt 2009; Mankiw and Reis 2002). In reality, these hypotheses do not conflict with each other and inflation expectations are formed through a combination of these factors. However, the dynamics of inflation expectations may change drastically depending on the extent to which each hypothesis holds true. To show this point, we conduct simulations using a small-scale model, albeit in an ad hoc framework.

In this simulation, we assume that the medium- to long-term inflation expectations follow the equation below, following Kitamura and Tanaka (2019). Here π_t^e denotes the medium- to long-term inflation expectation (6-10 years ahead), π_t^* the inflation target, τ_{t-1} the trend inflation rates and π_{t-1}^{yoy} the year-on-year inflation rates.

$$\pi_t^e = (1-\lambda-\mu)[\delta_t \pi_t^* + (1-\delta_t)\tau_{t-1}] + \lambda \pi_{t-1}^e + \mu \pi_{t-1}^{yoy} + \varepsilon_t \qquad (4)$$

In this model, we assume the existence of three different types of agents. The first type incorporates "rational inattention hypothesis" (composition ratio: $1-\lambda-\mu$). They form their inflation expectations, $\delta_t \pi_t^* + (1-\delta_t)\tau_{t-1}$, taking into the account the inflation target, π_t^*, and "long-run trend component of inflation rates (trend inflation rates)," τ_{t-1}. That is, these agents' inflation expectations are determined not only by the inflation target by the central bank, but also their past experience of inflation from a somewhat longer view. δ_t is the degree to which the agents focus on the inflation target (degree of anchoring to the inflation target), and we assume that it gets larger as inflation

[12] See, for example, Inatsugu et al. (2019), Kitamura and Tanaka (2019), Uno et al. (2018) for Japan; Coibion and Gorodnichenko (2015) for other countries.

expectations get closer to the inflation target. Note that, evidently from these formulations, "rational inattention" here means the inattention to the inflation target, not to the price developments and other factors.

$$\delta_t = (1-\theta)\delta_{t-1} + \theta\left[1 - \alpha\left(\frac{\pi_t^* - \pi_{t-1}^e}{\pi_t^*}\right)\right] \tag{5}$$

The second type of agents are those who follow the "sticky information hypothesis" (composition ratio: λ) and leave the previous period's inflation expectation unchanged. The third type is those who form inflation expectations based on the actual inflation rate at the time (composition ratio: μ). Though lacking theoretical foundations, we include it ad hoc to incorporate the mechanism of adaptive expectation formation, which plays an important role in the inflation expectation formations in Japan.

The other variables are modeled as follows. First, the inflation rate is assumed to follow a standard hybrid New Keynesian Phillips curve with its own lags (y_t denotes the output gap).

$$\pi_t = \rho\frac{\pi_{t-1} + \pi_{t-2}}{2} + (1-\rho)\pi_t^e + \gamma y_t + \eta_t \tag{6}$$

We assume that the trend inflation rates basically vary rigidly by its lagged term, but are updated gradually by taking the latest inflation rates into account very slightly.

$$\tau_t = (1-\kappa)\tau_{t-1} + \kappa\pi_t \tag{7}$$

With these specifications, we conduct the simulation to see how the medium- to long-term inflation expectations change when the cost-push pressure (η_t) first increases and then gradually decreases. Specifically, we assume the case when the oil prices rise by 22 percent (a similar rate of increase was seen in Dubai crude oil prices from December 2021 to March 2022) and then declines following the forward curve as of March 2022. We simulate two cases. The first case is when there are agents of type 1 alone ($\lambda = \mu = 0$). The second case is when there are agents of all three types of agents mentioned above ($\lambda > 0,\ \mu > 0,\ 1-\lambda-\mu > 0$). We estimated the model parameters using the Bayesian method.

Looking at the simulation results (Chart 13), in Case 1 with only the type-1 agents, inflation expectations continue to rise toward the inflation target, influenced by past experiences of low inflation, resulting in an increase of about +0.4 percentage points after three years. On the other hand, in Case 2 in which all three types are present, increases in inflation expectations become slower as there is a certain percentage of agents with unchanged expectations. In addition, agents that form expectations by taking actual inflation at each time into account lower their inflation expectations in response to a decline in cost-push pressures. As a result, the inflation expectation of the economy as a whole starts to decrease as cost-push pressures diminish, and the increase in expectations after three years is about +0.2 percentage points, smaller than in Case 1.

Thus, the future dynamics of inflation expectations can vary widely, both qualitatively and quantitatively, depending on how the expectations are formed. In reality, it is also likely that there are agents that form expectations in ways that cannot be expressed in the formulation in this section[13]. It is thought that the future development of inflation expectations is highly uncertain.

(2) Uncertainty of wage developments

As noted above, in Japan, the nominal wages growth rate has been declining since the 2000s at the same time that service prices have become stickier (Chart 8). How this interrelationship between nominal wages, prices, and inflation expectations will change, and whether the rigidity of nominal wages will change, are important in considering future price developments.

However, since there is a vast amount of studies on wage developments, a comprehensive discussion of developments in wages including their relationship with prices is well beyond the scope of this paper (for recent studies, see Heise et al. 2020; Ashenfelter and Jurajda 2021; etc.). Instead, we would like to point out two recent changes in Japan's labor market that are important for considering nominal wages in the future.

First, looking simply at wage statistics suggests that the rigidity of nominal wages in Japan may have eased in recent years. Data for wage revision rates (including regular salary increases) from the first half of 2000 to recent years (Charts 14 and 15) shows that the distribution of wage revision rates is concentrated in the 0-2% range and there are

[13] For example, Diamond et al. (2020) analyzed the formation of households' inflation expectations in Japan and noted that the formation of inflation expectations is influenced by the past long-term inflation experience of each generation.

extremely few cases that the revision rate is negative, which indicates the downward rigidity of nominal wages in Japan. On the other hand, there were peaks near zero percent, indicating a strong upward rigidity. As pointed out in previous studies, downward wage rigidity generates upward rigidity, as firms tend to (1) be reluctant to raise wages in subsequent economic recoveries if they did not cut wages during past recessions or (2) avoid raising wages in the present because they are aware of the risk of future wage cuts (Hirata et al. 2020; Yamamoto and Kuroda 2017; etc.). However, in recent years, the percentage of firms with wage revision rates near zero percent has declined significantly,. It is necessary to further analyze whether this means that wages have become less upwardly rigid, meaning that wages are more likely to rise in response to rising prices, tighter labor supply and demand, and other factors.

The second is the changes in labor supply reflecting demographic changes and other factors. In particular, it is known that wages of part-time workers and other non-full-time employees tend to change sensitively reflecting labor supply and demand because of their exposure to the external labor market. Conversely, rising labor demand and wages have an impact on labor supply in some ways. In this regard, in the 2010s, with the employment situation improving significantly, labor participation by women and the elderly (especially the elderly in their 60s and early 70s in the early period), for whom the wage elasticity of labor supply is high, increased (Chart 16(1)). However, there is some uncertainty as to whether labor supply will continue to increase as it did before COVID-19, while the impact of pandemic continues to ease in the future. As for women, while labor supply may continue to increase due to the rise in the working hours of those who usually work shorter hours, the so-called "M-shaped curve" of the labor force participation rate has already eased to a considerable extent, and the room for additional labor participation may be limited. It is also important to note that recent demographic trends (Chart 16(2)) indicate that a structural change is taking place, with the so-called "baby boomers" entering the later stages of their lives. Looking ahead, the labor participation rate for the elderly population as a whole is likely to plateau, as the population of the elderly aged 74 and younger, who have supported the labor supply growth in recent years, is certain to decline. Another point of interest will be whether a change in the upward trend of labor supply ahead will increase the structural labor shortages (Chart 16(3)), and whether this will affect wages.

5. Concluding remarks

In this paper, we summarize the characteristics of price developments in Japan, dividing them into trends prior to COVID-19 and recent changes, and then discuss some of the issues surrounding future price developments.

The nature of price developments in Japan before COVID-19 is represented by the flattening of the Phillips curve since the 2000s. In particular, Japan differs significantly from the U.S. in that, since 2000, service prices have been hovering stickily around zero percent under a low inflation environment. On the other hand, recent price developments show that cost-push pressure is increasing not only in the U.S. and Europe but also in Japan, especially in the goods sector, due in part to the effects of rising commodity prices. However, as far as the average historical relationship is concerned, such cost-push pressures, while temporarily boosting prices, are unlikely to lead to the realization of sustainable price stability. In order to achieve sustainable price stability, it would be important for prices to rise along with improvement in economic activity, and for medium- to long-term inflation expectations to rise and wage growth to be realized under such circumstances.

This paper aimed to contribute to the deepening of the debate over prices, with a primary focus on summarizing price developments in Japan. Looking ahead, it will be important to further develop the discussion on the stickiness of service prices, the rigidity of nominal wages, the uncertainty of inflation expectations, and other issues, which are characteristic of Japan.

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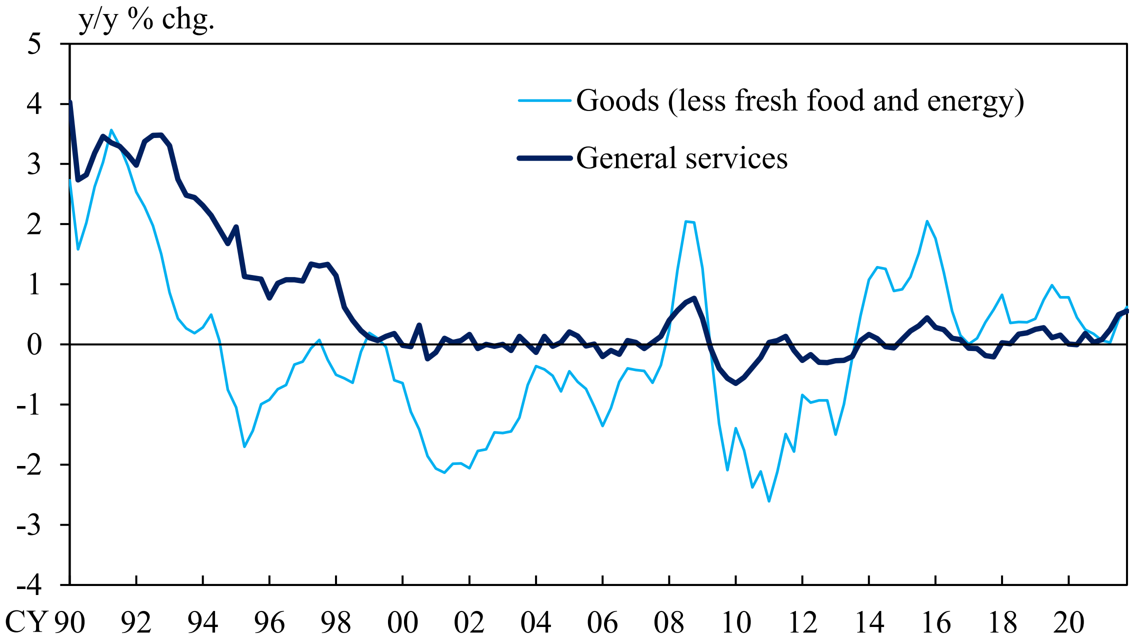
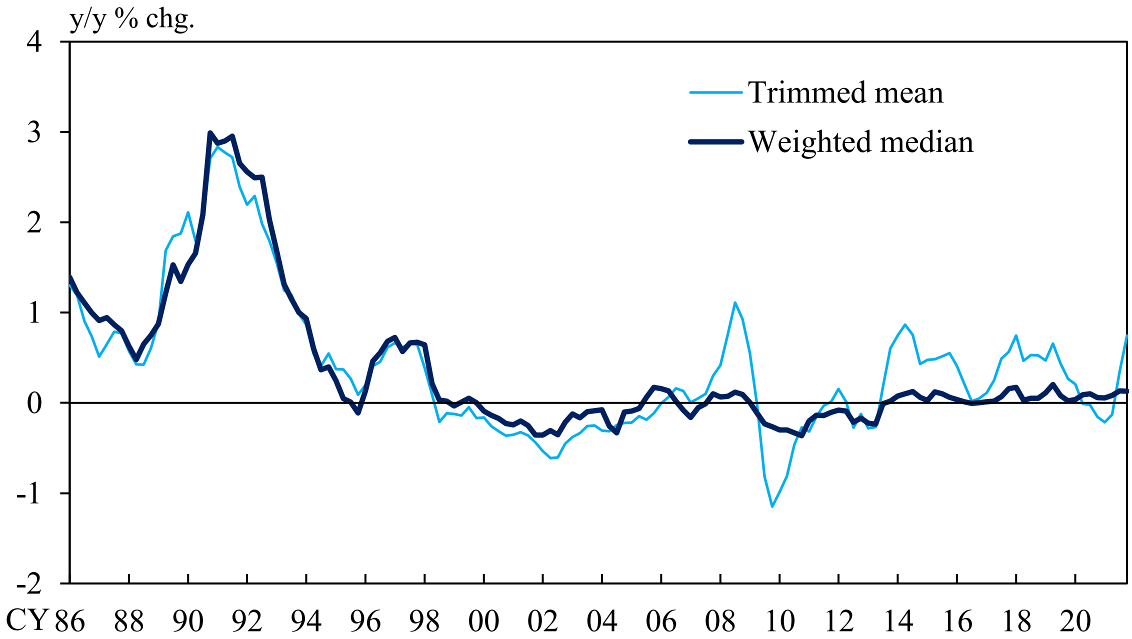
Price Developments in Japan

(1) Consumer prices for goods and services



Note: The CPI figures are staff estimates and exclude the effects of the consumption tax hike, policies concerning the provision of free education, and the "Go To Travel" campaign, which covers a portion of domestic travel expenses. Figures for general services from 2021 exclude mobile phone charges.
Source: Ministry of Internal Affairs and Communications.

(2) Weighted median and trimmed mean

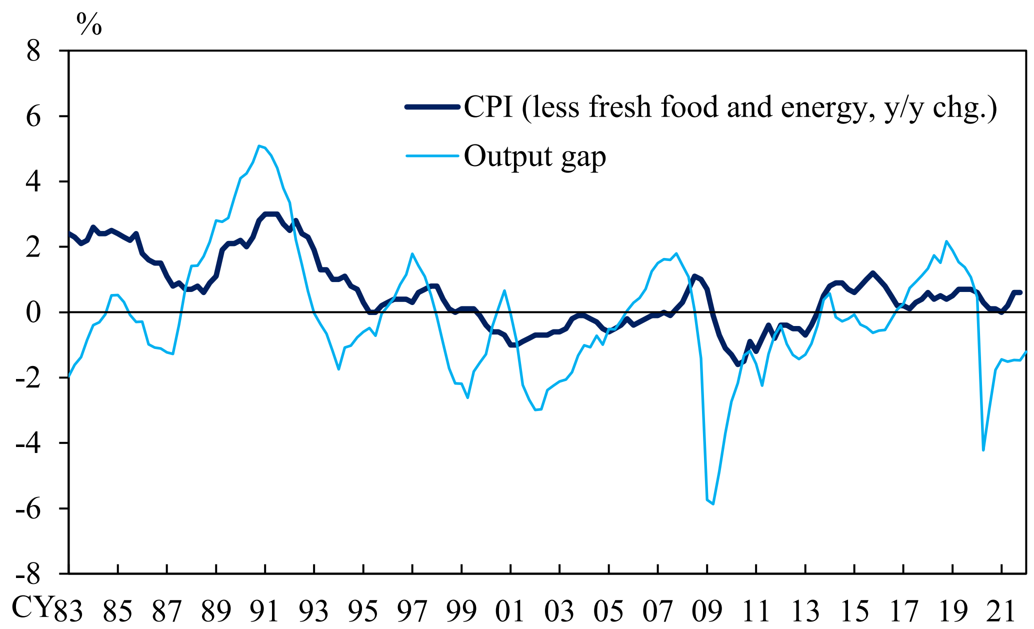


Note: Figures are for items of each base year. Latest data as at 2021/4Q.
Sources: Bank of Japan; Ministry of Internal Affairs and Communications.

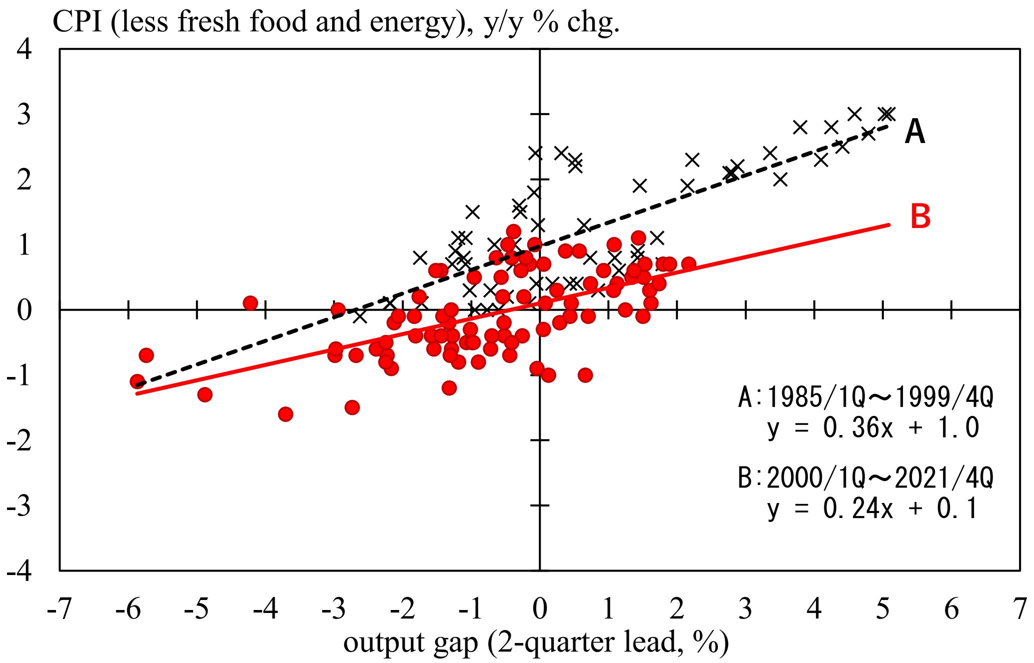
Chart 2

Phillips Curve in Japan

(1) CPI and the output gap



(2) Phillips curve



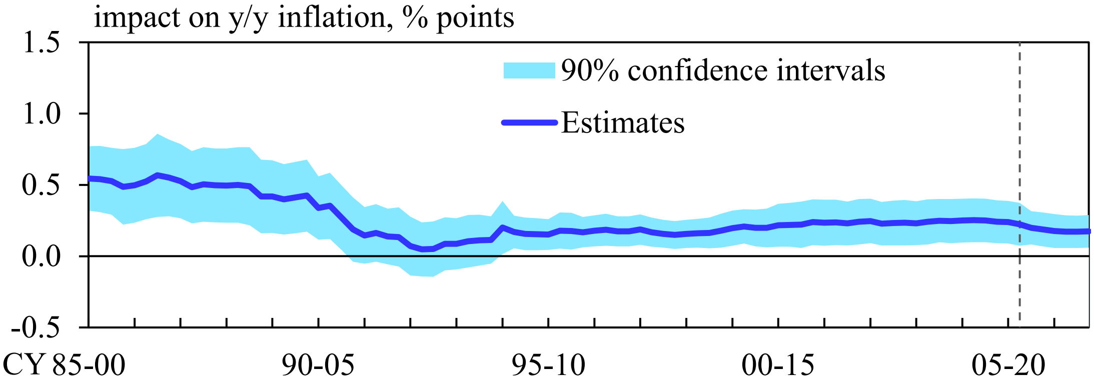
Notes: 1. The CPI figures are staff estimates and exclude mobile phone charges and the effects of the consumption tax hikes, policies concerning the provision of free education, and the "Go To Travel" campaign, which covers a portion of domestic travel expenses.
2. Figures for the output gap are staff estimates.

Sources: Ministry of Internal Affairs and Communications; Bank of Japan.

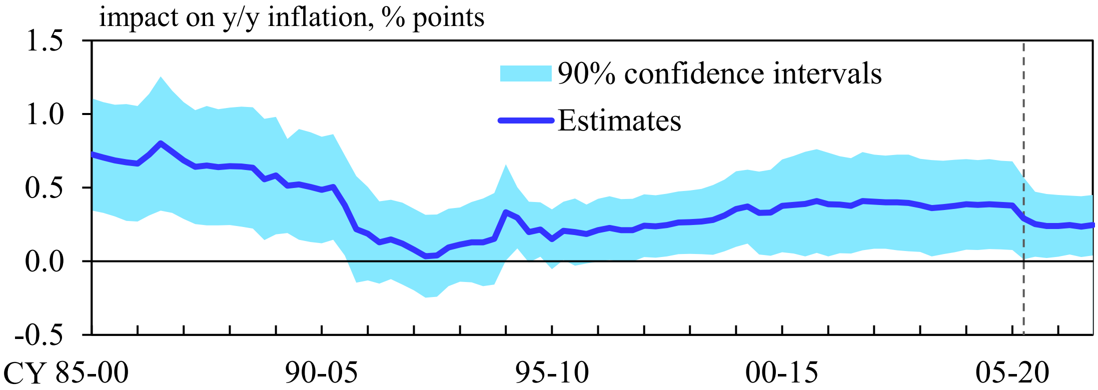
Chart 3

Changes in the Slope of the Phillips Curve (1) VAR Analysis

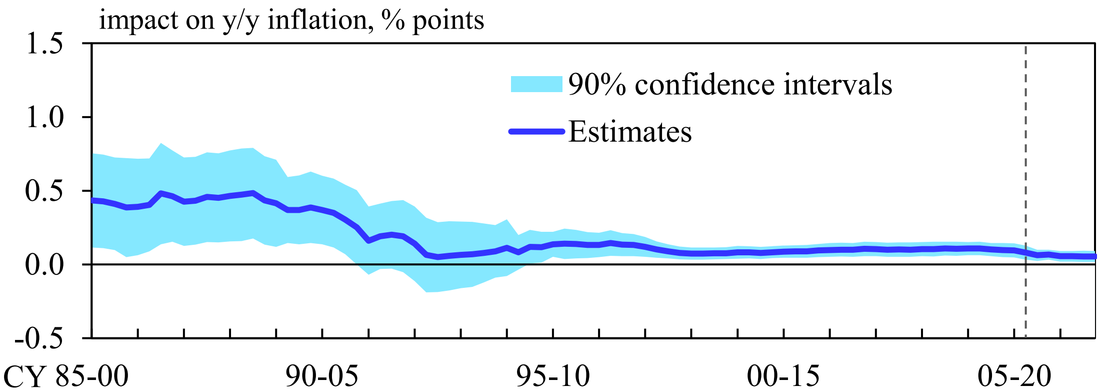
(1) All items (less fresh food and energy)



(2) Goods (less fresh food and energy)



(3) General services



Notes: 1. The figures show the accumulated impulse responses (at 8th period, annualized) of inflation rates to the +1 percentage point output gap shock by the VAR model with two lags consisting of import prices (contract currency basis, all commodities, s.a., log difference) as the exogenous variable, and dollar-yen exchange rate (log difference), middle- to long-term inflation expectations, the output gap and CPI (all items less fresh food and energy) as the endogenous variables.

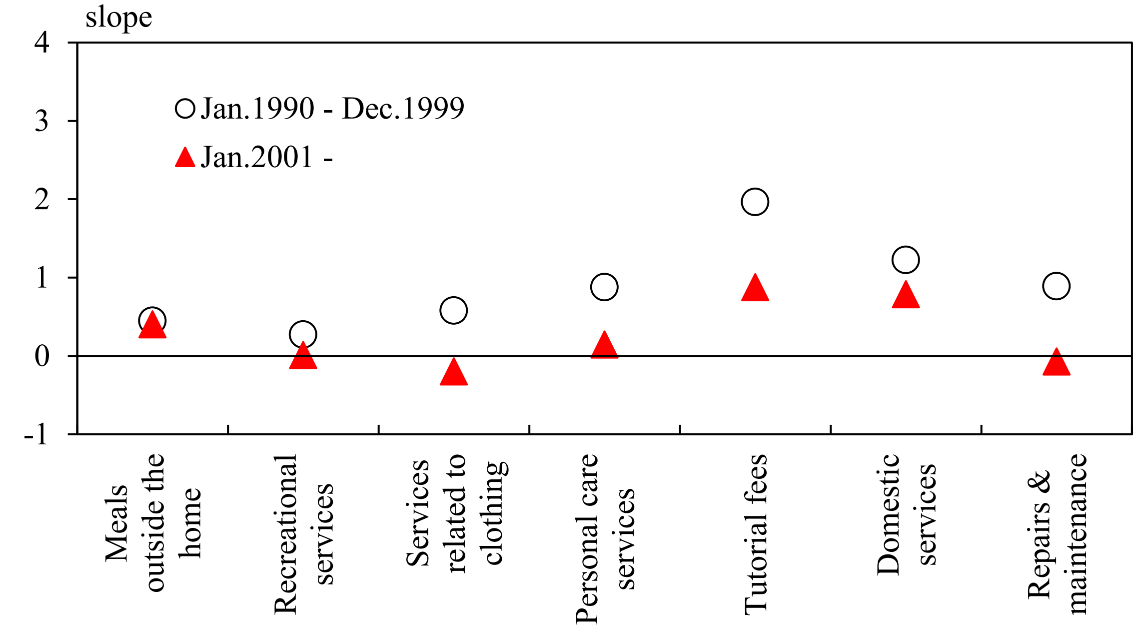
2. CPI excludes mobile phone charges and the effects of the consumption tax hike, policies concerning the provision of free education, and the "Go To Travel" campaign, which covers a portion of domestic travel expenses.

3. The rolling window is 60 quarters. The dotted line indicates the sample includes 2020/1Q.

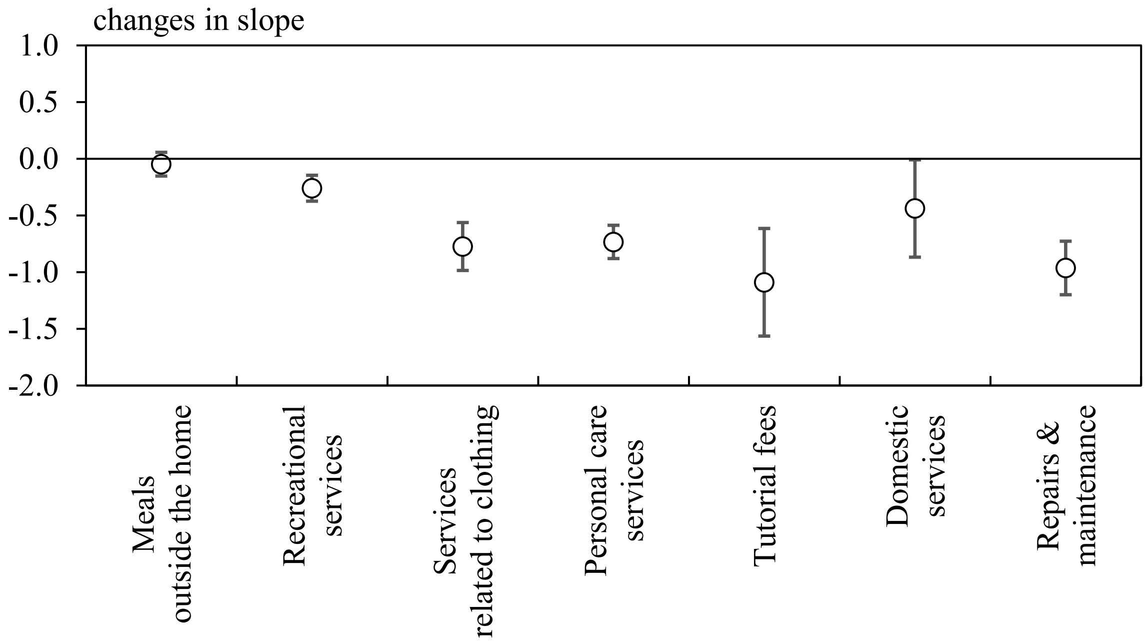
Sources: Ministry of Internal Affairs and Communications; Bank of Japan; Consensus Economics Inc., "Consensus Forecasts," etc.

Changes in the Slope of the Phillips Curve (2) Panel-Data Analysis

(1) Slope of the Phillips curve



(2) The Changes in the slope of the Phillips curve



Notes: 1. The circle and triangle markers in figure (1) indicate β_1 and $\beta_1+\beta_2$ of the equation (2) in the text, respectively.

2. The circle markers in figure (2) indicate β_2 of the equation (2) in the text. The vertical lines indicate the 95% confidence intervals.

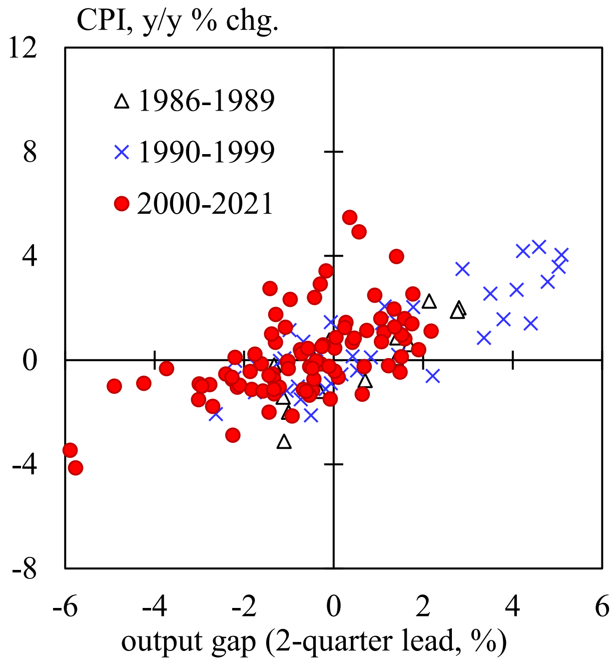
3. For each services, we choose the length of lags of the active job openings-to-applicants ratio which maximizes the adjusted R^2.

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

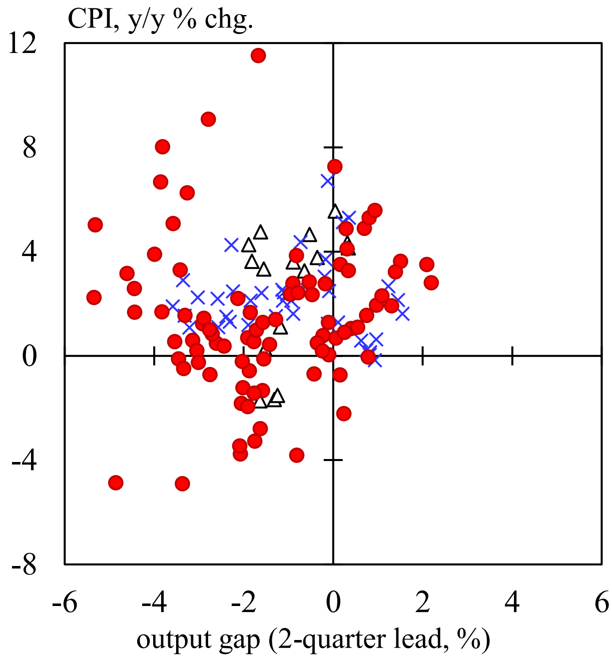
International Comparison (1) Phillips Curves in Japan and U.S.

(1) Goods

(i) Japan

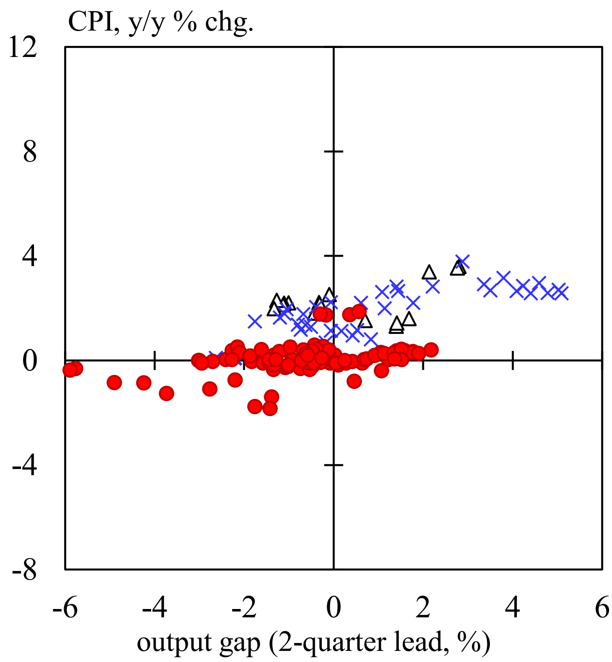


(ii) United States

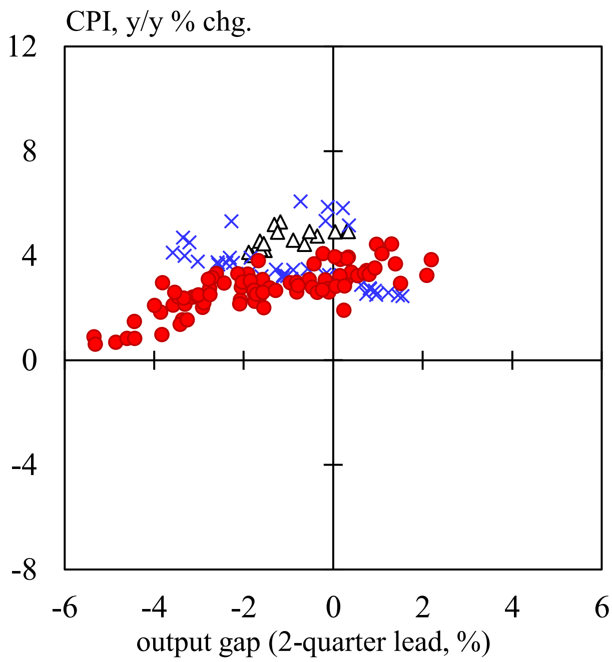


(2) Services

(i) Japan



(ii) United States



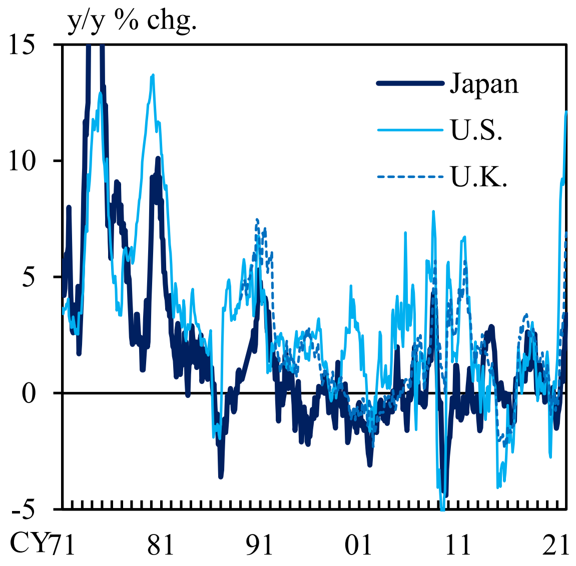
Sources: Ministry of Internal Affairs and Communications; FRED; Haver; Bank of Japan.

Chart 6

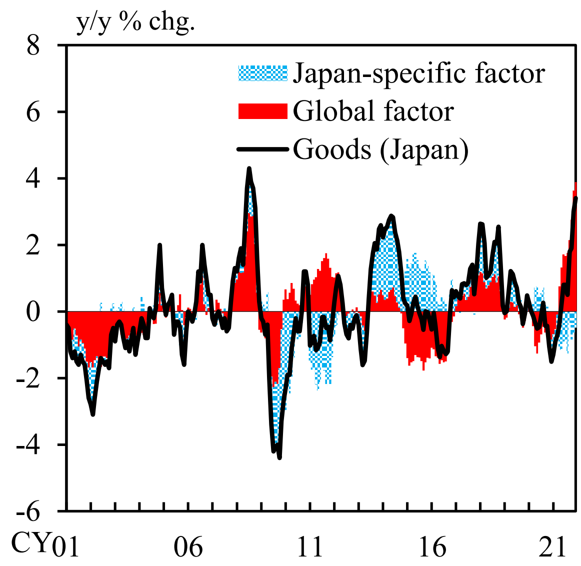
International Comparison (2) Principal Component Analysis of Inflation Rates

(1) Goods

(i) Inflation rates

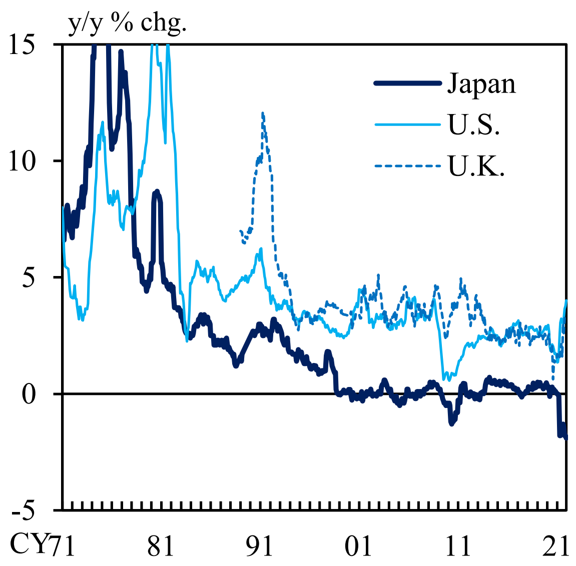


(ii) Principal component analysis

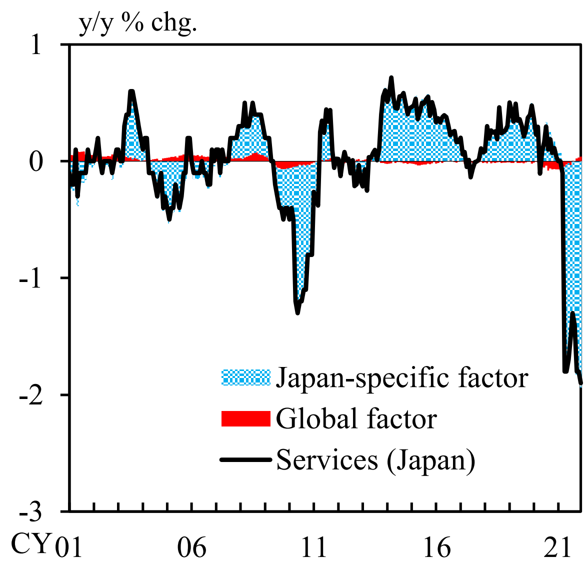


(2) Services

(i) Inflation rates



(ii) Principal components analysis



Notes: 1. The definitions of goods and services are based on those of statistical office of each country. For Japan, figures exclude the effects of the consumption tax hikes.

2. The figures on the right show the results of principal component analysis for inflation rates of Japan, the U.S. and the U.K. We regard the first principal component as the global factor.

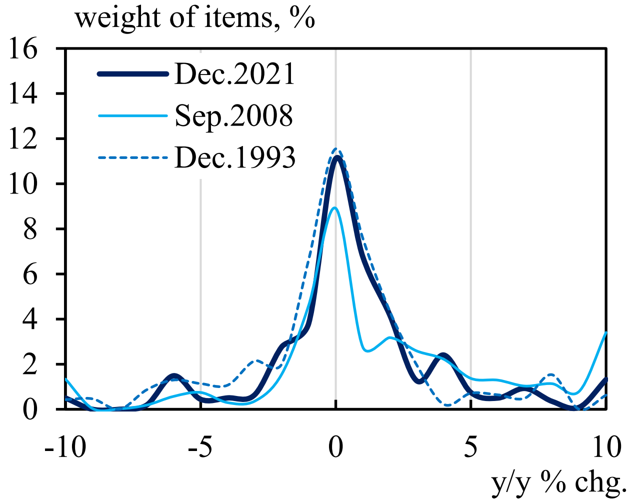
Sources: Ministry of Internal Affairs and Communications; BLS; ONS.

Chart 7

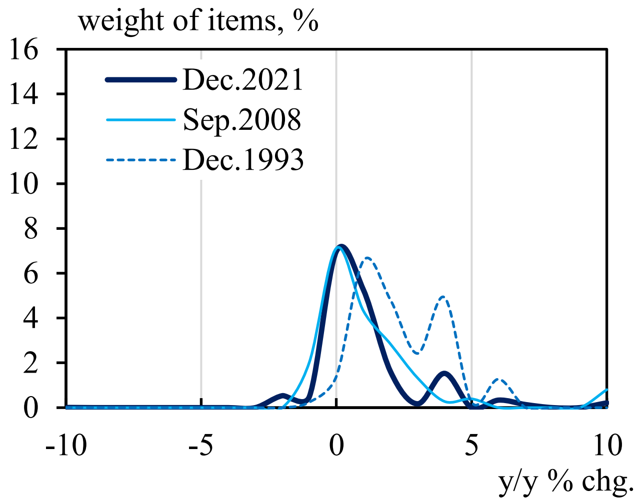
Price Change Distribution

(1) Consumer Price Index

(i) Goods (less fresh food and energy)



(ii) General Services

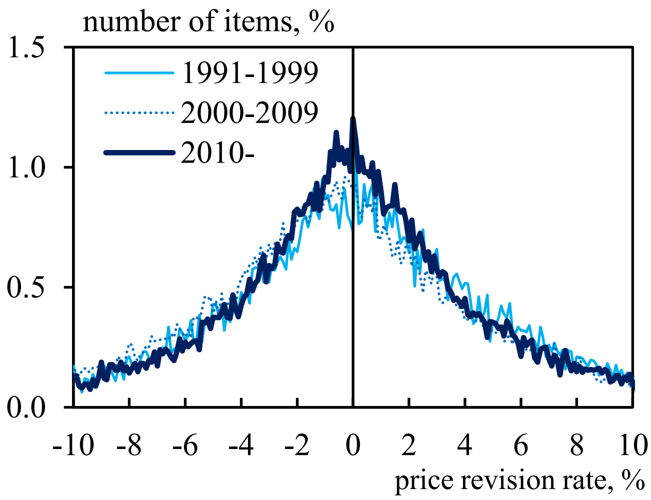


Notes: 1. Figures are for items of each base year. The weight of items is that in the CPI (less fresh food).
2. For general services, housing rent and mobile phone charges are excluded.
3. The CPI figures are staff estimates and exclude the effects of the "Go To Travel" campaign, which covers a portion of domestic travel expenses. Figures exclude fresh food and energy.

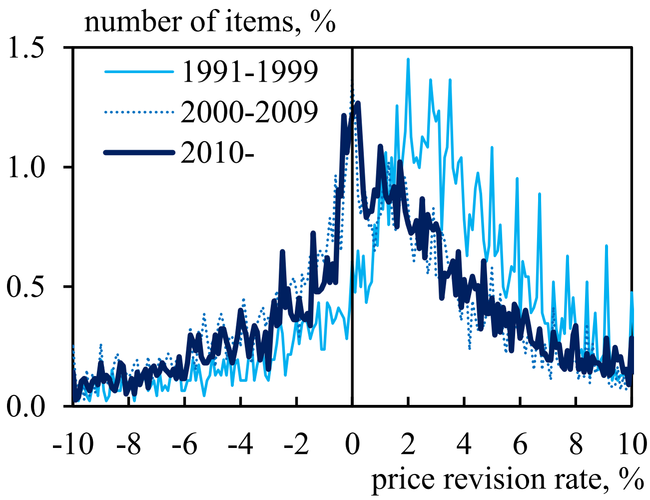
Source: Ministry of Internal Affairs and Communications.

(2) Price Revition Rates (Retail Price Survey)

(i) Goods (less fresh food and energy)



(ii) Services

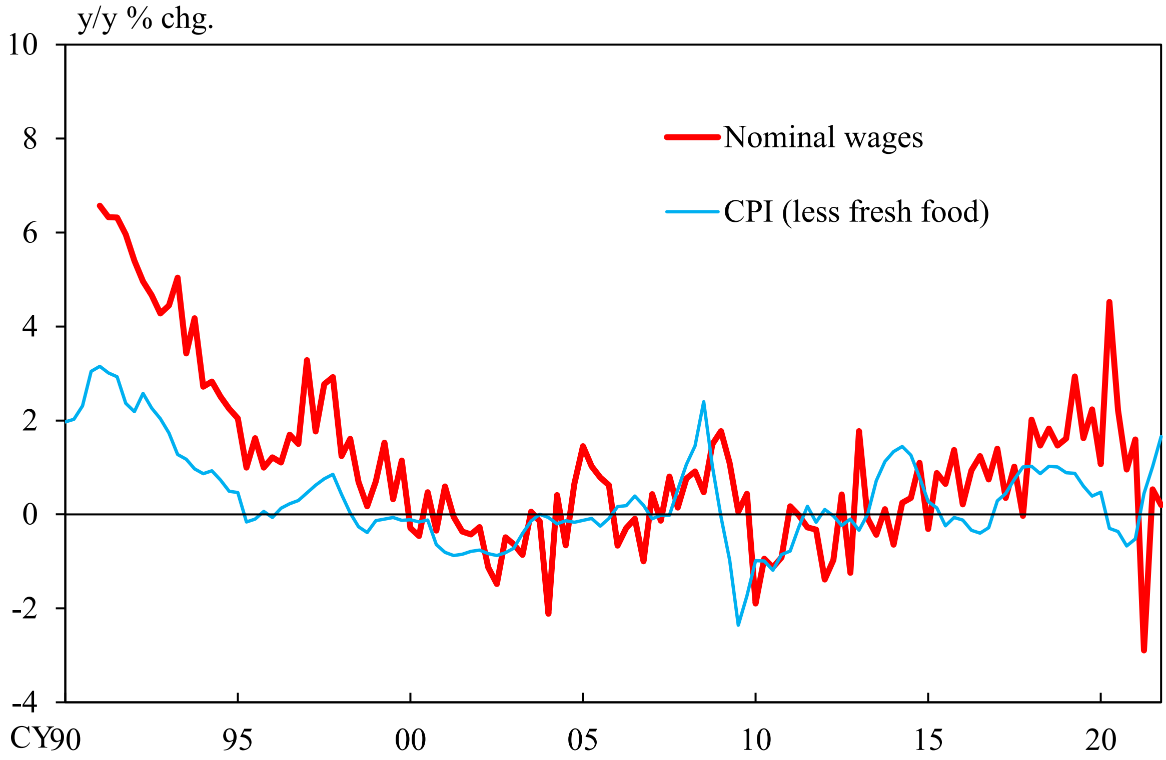


Note: The number of items is counted in 0.1 percentage point increments for the monthly revision rate at the time of revision and divided by the number of items included.
The mode prices for two months before and after each month (five months in total) are used.

Source: Ministry of Internal Affairs and Communications.

Chart 8

Wages and Prices in Japan

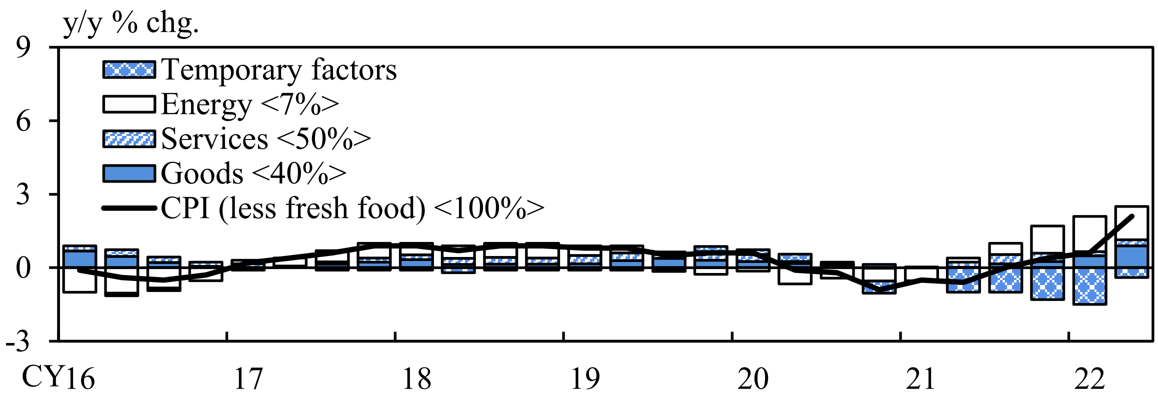


Notes: 1. Nominal wage = (scheduled cash earnings + non-scheduled cash earnings) / (total hours worked).
The figures are those of full-time and part-time employees
(establishments with 5 or more employees).
2. The CPI figures are staff estimates and exclude mobile phone charges.

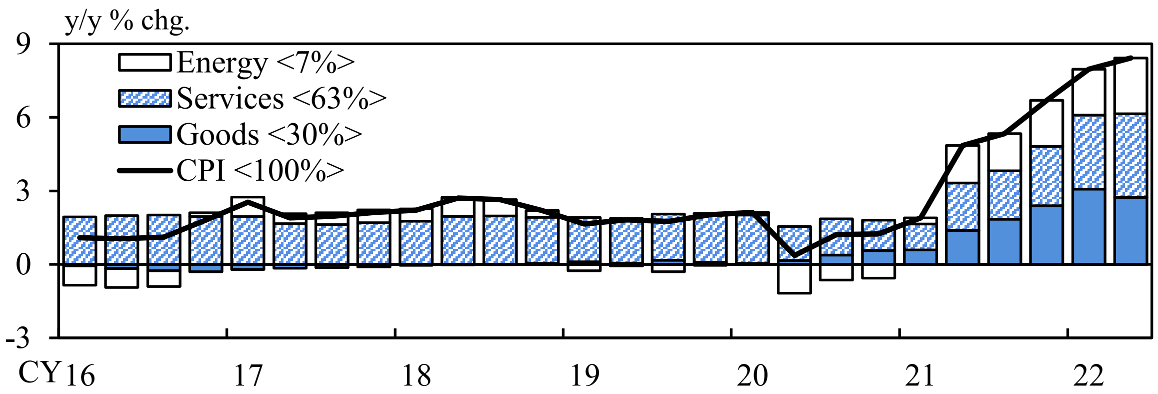
Sources: Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare.

Developments in Consumer Prices in Japan, the United States, and Europe

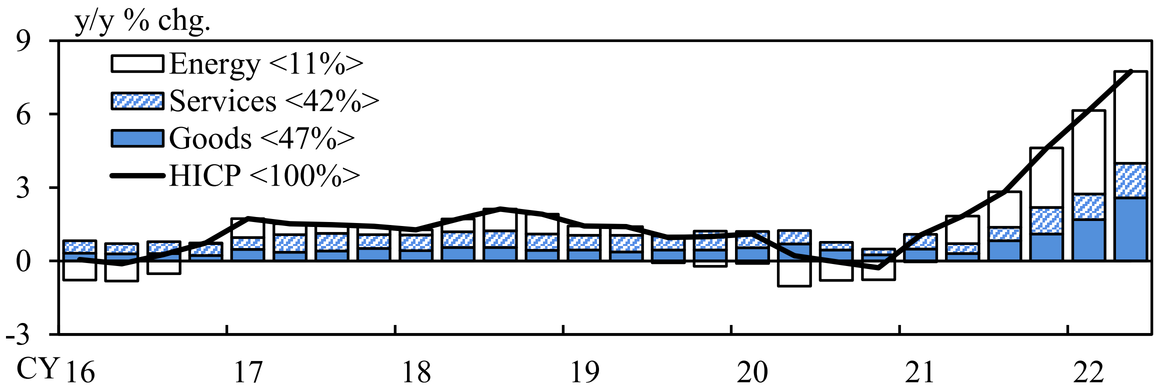
(1) Japan



(2) United States



(3) Euro Area



Notes: 1. Figures for services include administered prices.

2. Figures for temporary factors for Japan are staff estimates and consist of mobile phone charges and the effects of the consumption tax hike, policies concerning the provision of free education, and the "Go To Travel" campaign, which covers a portion of domestic travel expenses.

3. Figures in angular brackets show the share of each component.
Figures for temporary factors for Japan include mobile phone charges (weight: 3%).

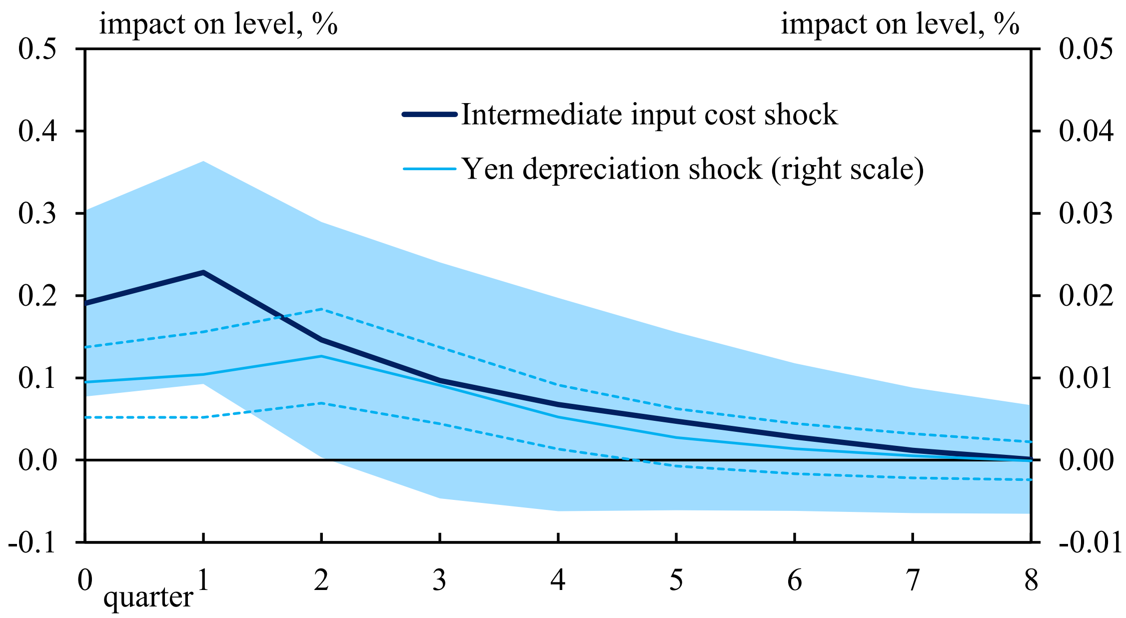
4. Figures for 2022/Q2 are those of the April-May average.

Sources: Ministry of Internal Affairs and Communications; Haver.

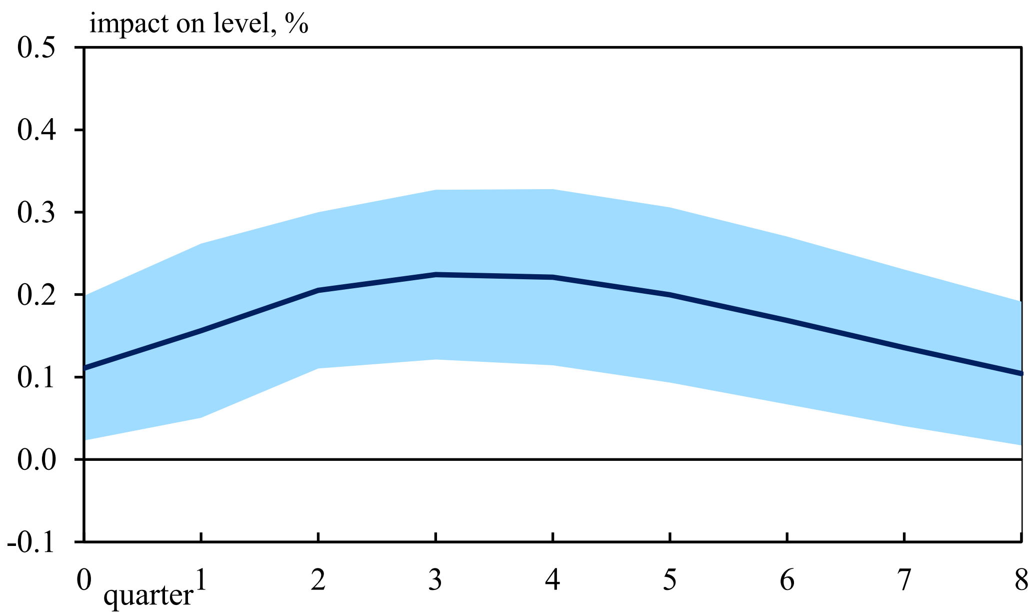
Chart 10

Responses of Prices to Intermediate Input Cost and Output Gap Shocks

(1) Impulse Responses to Intermediate Input Cost Shock



(2) Impulse Responses to Output Gap Shock



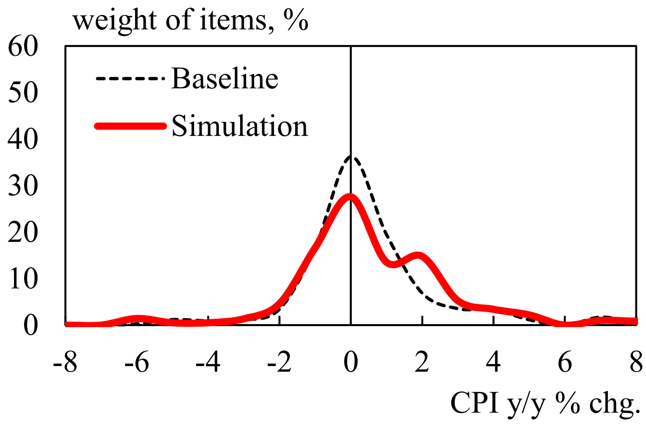
Note: The charts show the impulse responses of CPI at each time (not cumulative responses) to a +1% shock of each variable. The VAR (two-period lag) model consists of nominal effective exchange rate, intermediate input cost index, output gap, and CPI (less fresh food, energy, mobile phone charges, etc.). The shaded areas and dashed lines indicate the 75% confidence intervals.

Sources: Ministry of Internal Affairs and Communications; Bank of Japan.

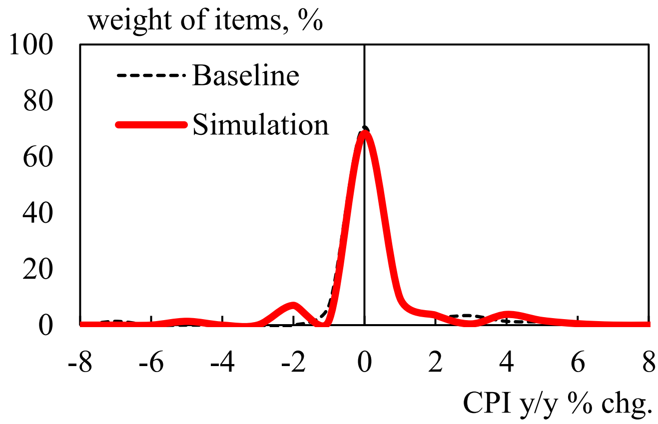
Simulation of the Distribution of CPI Inflation

(1) Shock on Import Price

(i) Goods

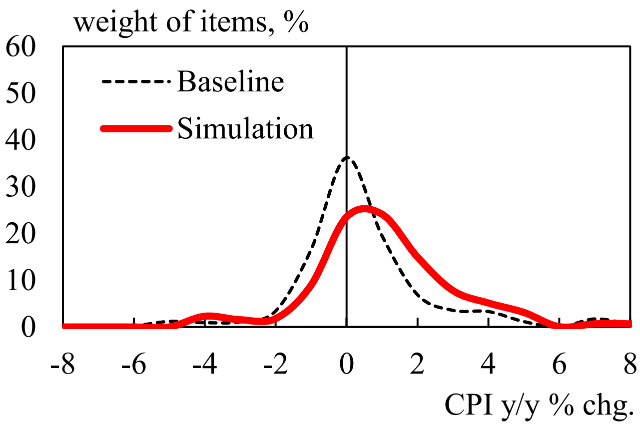


(ii) Services

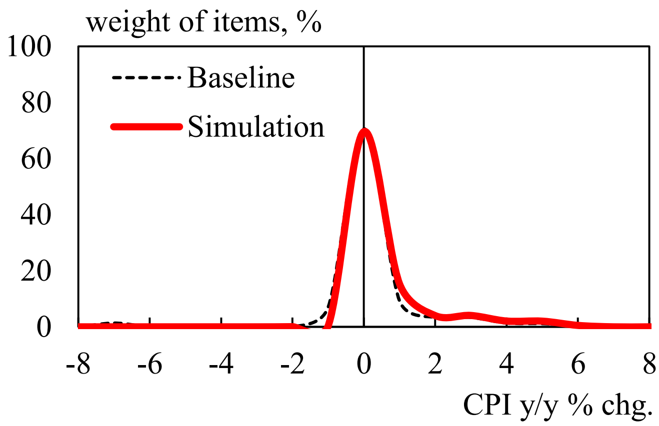


(2) Shock on Output Gap

(i) Goods

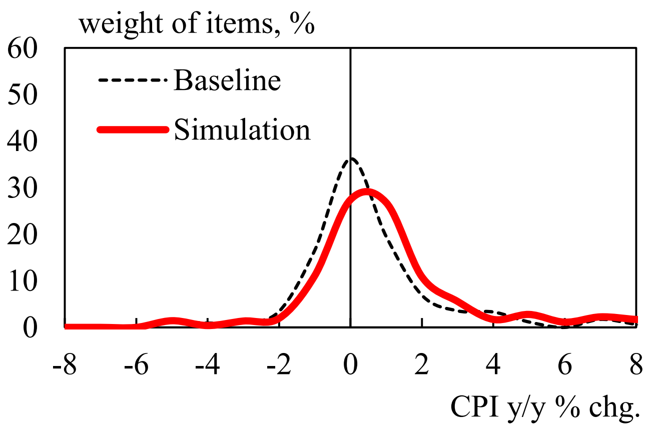


(ii) Services

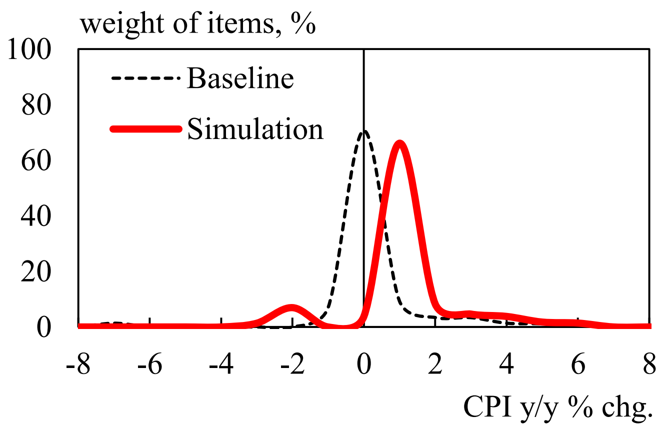


(3) Shock on Medium- to Long-term Inflation Expectations

(i) Goods



(ii) Services

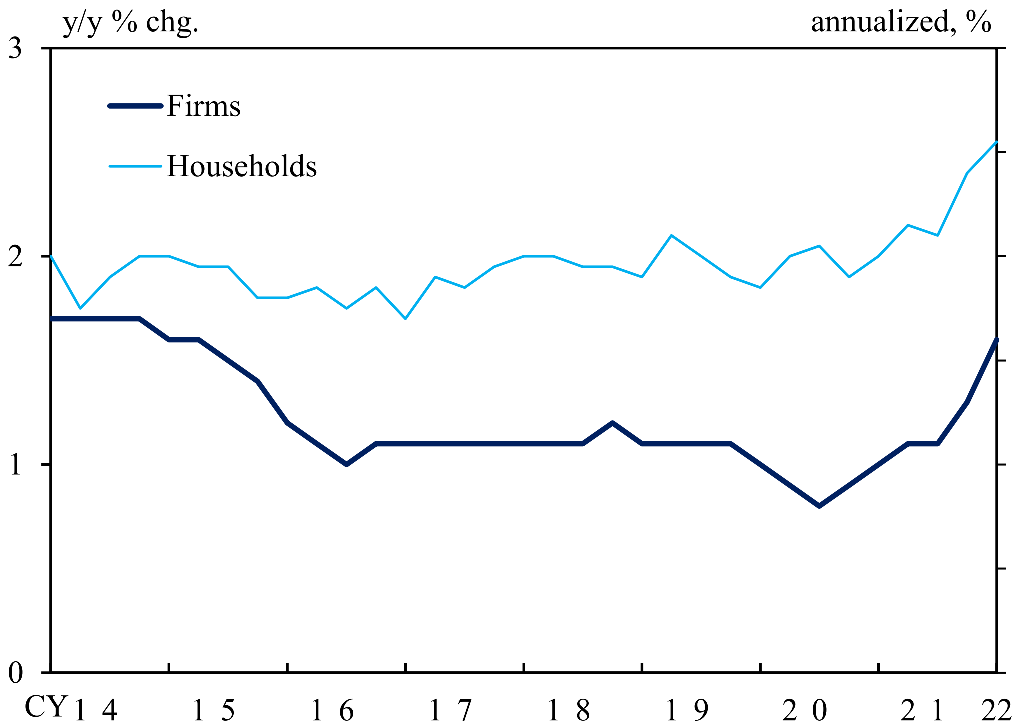


Notes: 1. For each simulation, the regression model includes the consumption tax hike dummies as explanatory variables.
2. "Baseline" indicates figures for 2021/4Q.

Sources: Ministry of Internal Affairs and Communications; Bank of Japan; Consensus Economics Inc., "Consensus Forecasts."

Chart 12

Medium- to Long-Term Inflation Expectations of Firms and Households



Notes: 1. The figures are for five-year ahead expectations.
2. Figures for firms show the inflation outlook of enterprises for general prices (all industries and enterprises, average) in the *Tankan* ; figures for households are from the *Opinion Survey on the General Public's Views and Behavior.*

Source: Bank of Japan.

Chart 13

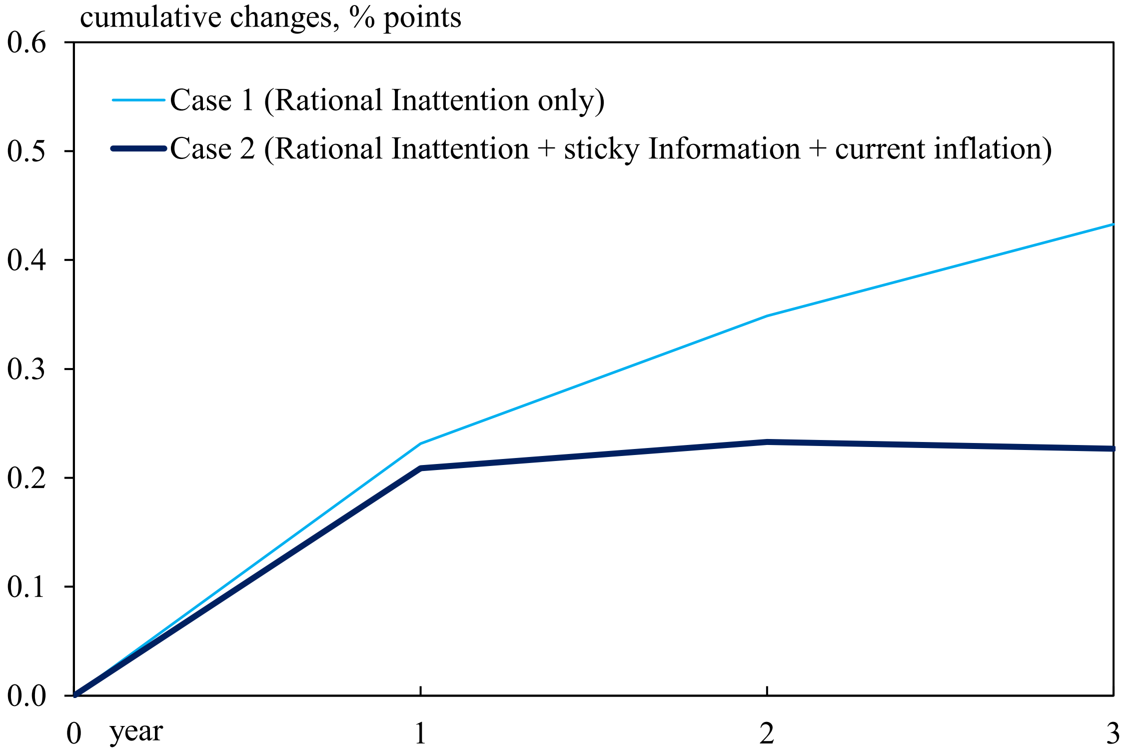
Simulation for Medium- to Long-Term Inflation Expectations

(1) Composition of Agents

	Proportion	Case 1	Case 2
Agents subject to rational inattention	$1-\lambda-\mu$	100	43
Agents subject to sticky information	λ	0	52
Agents considering current inflation	μ	0	5

composition ratio, %

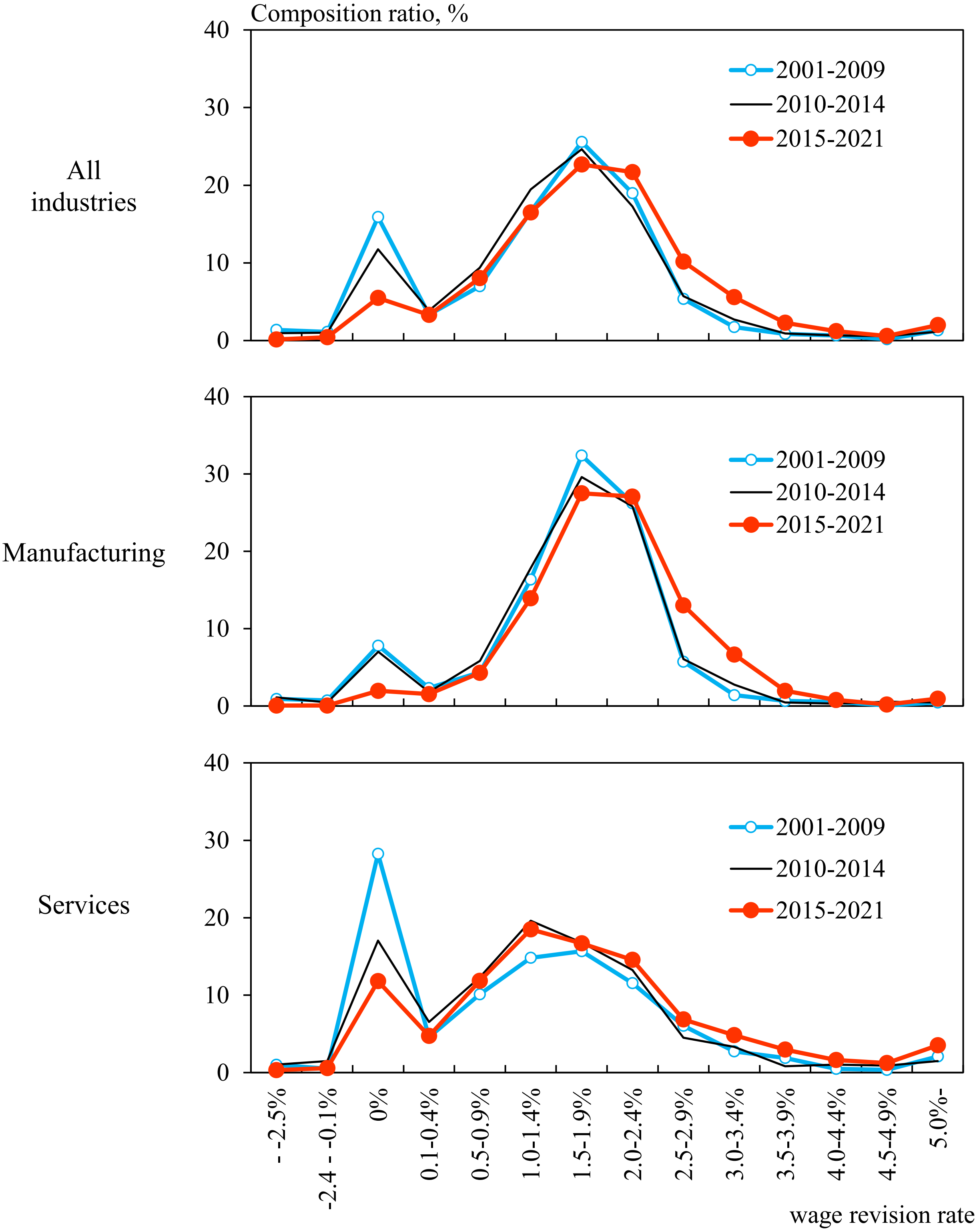
(2) Simulation Results



Sources: Ministry of Internal Affairs and Communications; Bank of Japan;
Consensus Economics Inc., "Consensus Forecasts."

Chart 14

Distribution of Wage Revision Rates (1) All Firm Sizes

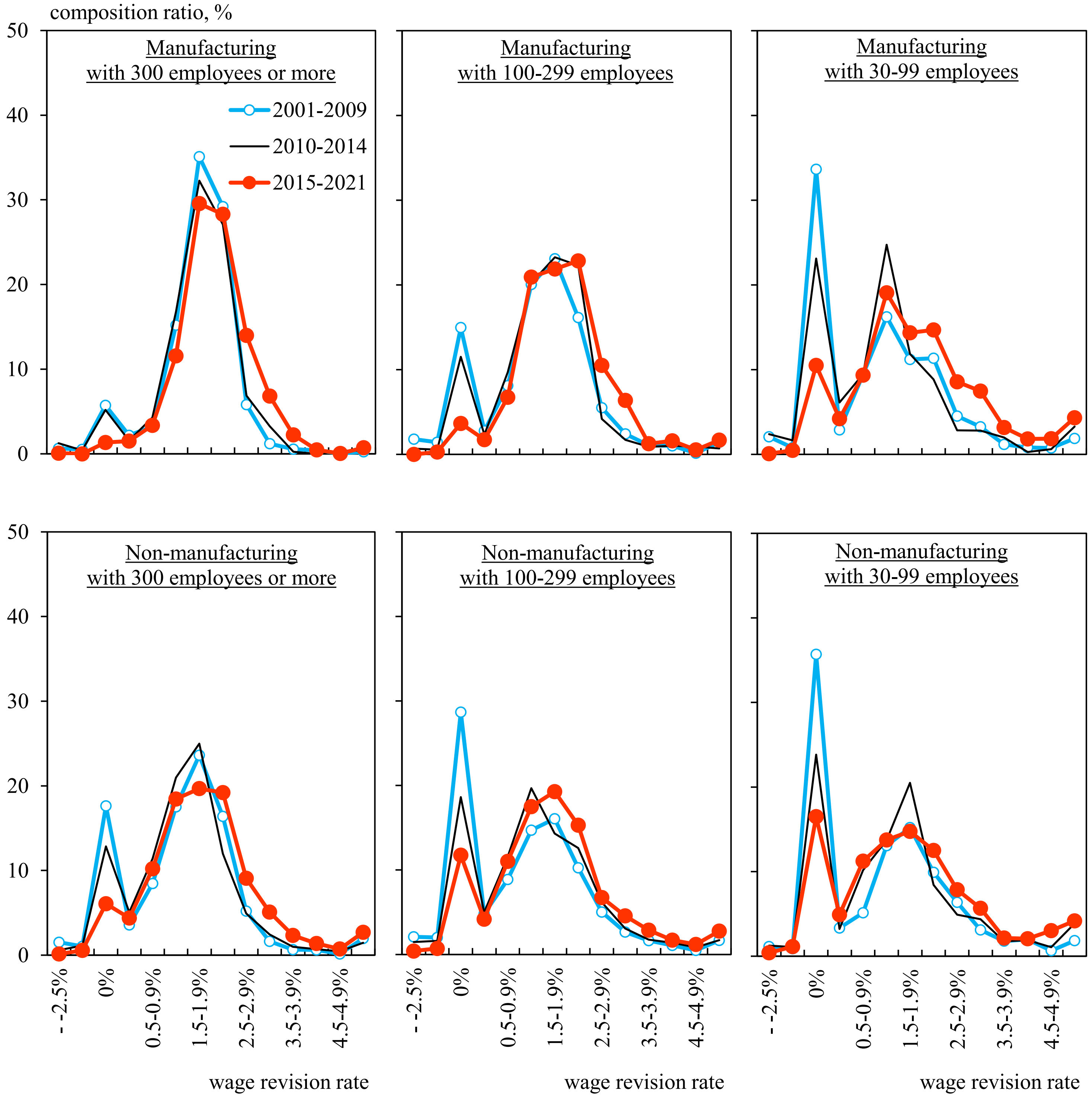


Note: "Services" is the sum of "Accommodations, eating and drinking services," "Living-related and personal services and amusement services," "Medical, health care and welfare," "Education, learning support," "Scientific research, professional and technical services," and "Services (not elsewhere classified)."

Source: Ministry of Health, Labour and Welfare.

Chart 15

Distribution of Wage Revision Rates (2) By Firm Size

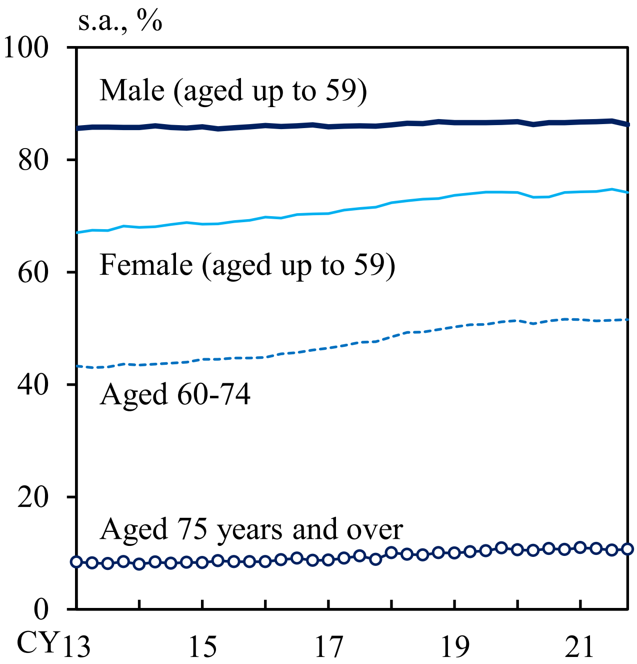


Source: Ministry of Health, Labour and Welfare.

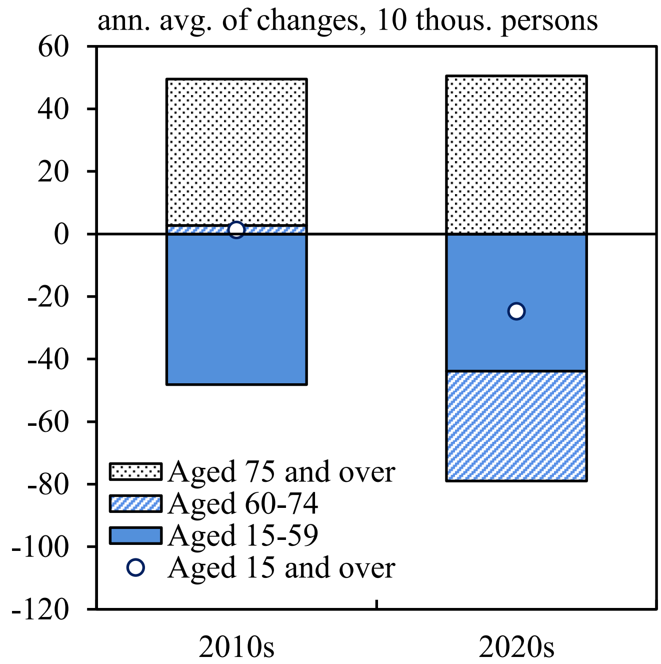
Chart 16

Changes in Trends in Labor Supply

(1) Labor Force Participation Rate

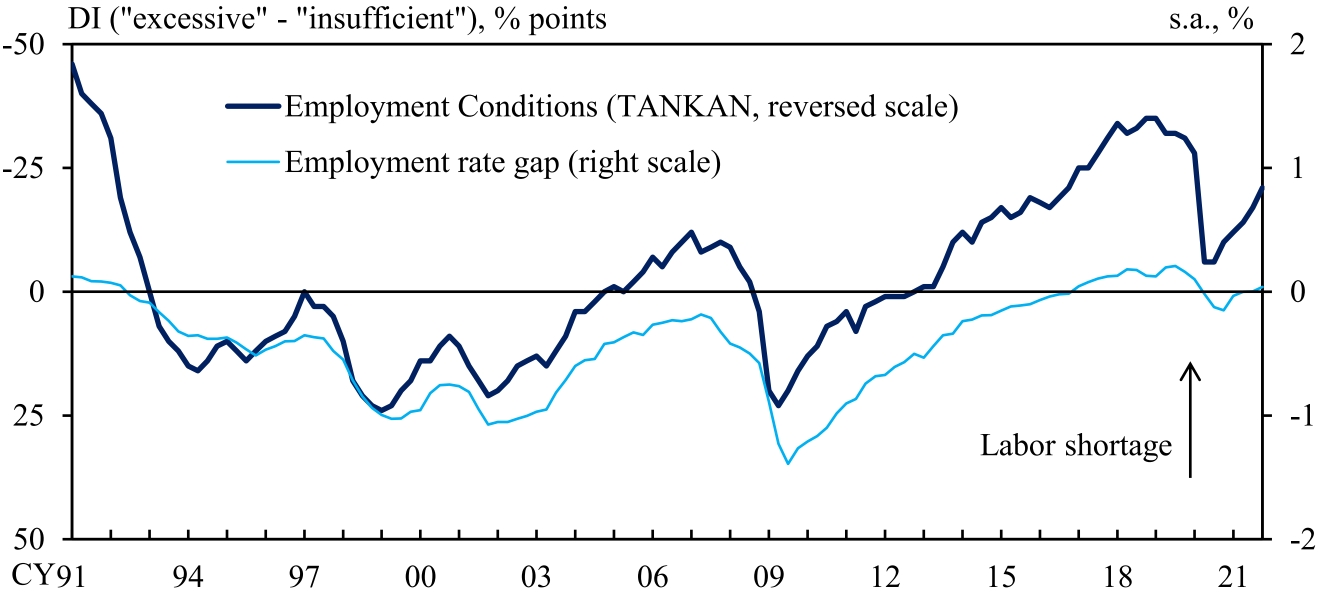


(2) Demographic Changes by Age



Notes: The figures for 2020s in (2) is based on the population projection (medium-fertility and medium-mortality) to 2024.
Sources: Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare; National Institute of Population and Social Security Research.

(3) Labor Shortage



Note: Employment conditions is for all industries and enterprises. There is a discontinuity in the data in December 2003 due to a change in the survey framework.
Source: Bank of Japan.