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Updates on the Output Gap and Potential Growth Rate, and Monitoring Labor Market Indicators

Research and Statistics Department
Bank of Japan

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Abstract

The Research and Statistics Department of the Bank of Japan has revised the methodology for calculating the output gap and potential growth rate, which are regularly estimated and released, taking into account the benchmark year revision of 2020 in GDP statistics and recent changes in economic structure. The main changes include: (1) regarding the capital utilization rate, the source data has been changed from a quantity basis to a "value-added basis," which accounts for quality improvements, resulting in an adjustment of the downward bias that has occurred in capital utilization rate for the manufacturing sector; (2) for the structural unemployment rate, the estimation method has been revised to more accurately capture mismatches in the labor market, given the recent shift from the use of the Public Employment Security Office to the use of private employment agencies; and (3) the potential growth rate has been re-estimated using the 2020 base-year GDP and capital stock statistics, through the calculation of the total factor productivity growth rate.

In order to assess economic and price developments, using estimates of the output gap to identify the aggregate supply and demand balance remains critical. However, in recent years, and amid intensifying labor supply constraints, developments in labor input and labor market tightness appear to exert an increasingly significant influence on economic activity in labor-intensive sectors and price trends. Against this backdrop, this paper also conducts a brief empirical performance exercise of labor market indicators that are considered to be suitable for complementary monitoring of the output gap, given their relevance to forecasting wages and prices.

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1. Introduction

In order to assess and analyze economic and price developments, the "output gap," which represents the difference between total demand in the goods and services markets and the average supply capacity (potential GDP), and the potential growth rate (the growth rate of potential GDP), are important concepts. For this reason, the Research and Statistics Department of the Bank of Japan releases quarterly estimates of the output gap and potential growth rate as "Research Data." Many central banks and international organizations also estimate and release various supply-demand balance indicators, including the output gap, depending on the specific characteristics of the country or region, and use them to assess economic conditions (see Box for details).

This paper describes the revisions of the estimation methodology for the output gap and potential growth rate, taking into account the benchmark revision year of 2020 in GDP statistics and recent changes in economic structure.[1] The Research and Statistics Department directly estimates the output gap from the utilization rates (the utilization gap, or the deviation from the trend) of production factors—capital and labor—under the assumption of a Cobb-Douglas production function for the economy as a whole. The basic approach of estimating the output gap from production factor utilization without using GDP remains unchanged in this revision,[2] but the methods for estimating the respective gaps for capital and labor have been modified as follows. For manufacturing capital utilization, the source data has been changed from a quantity basis to a "value-added basis," which accounts for quality improvements, resulting in an adjustment of the downward bias that has occurred in capital utilization rate for the manufacturing sector. Regarding labor: first, for the structural unemployment rate used to calculate the employment rate gap, the estimation method has been revised to more accurately capture mismatches in the labor market, given the recent shift from the use of the Public Employment Security Office to the use of private employment agencies. Second, for the labor force participation rate gap, the trend estimation method has been further subdivided by gender and age group, taking into account the heterogeneity in developments of labor force participation amid the further progress of labor participation by women and the

[1] The Research and Statistics Department of the Bank of Japan updates the methodology for estimating the output gap and the potential growth rate on a continuous basis, taking into account the economic environment and available statistics at each point in time. For details on the 2006 revision, see Hara et al. (2006); for the 2017 revision, see Kawamoto et al. (2017).

[2] The output gap estimated by the Research and Statistics Department of the Bank of Japan does not use GDP statistics in the sense that the gap is not estimated as "the deviation between actual GDP and potential GDP." Strictly speaking, however, the labor share used to calculate the weighted average of the utilization gap for each production factor is based on GDP statistics. Furthermore, as described later, the revision this time utilizes information from the quarterly national accounts (QNA) for value added from the production side when estimating manufacturing utilization gap.

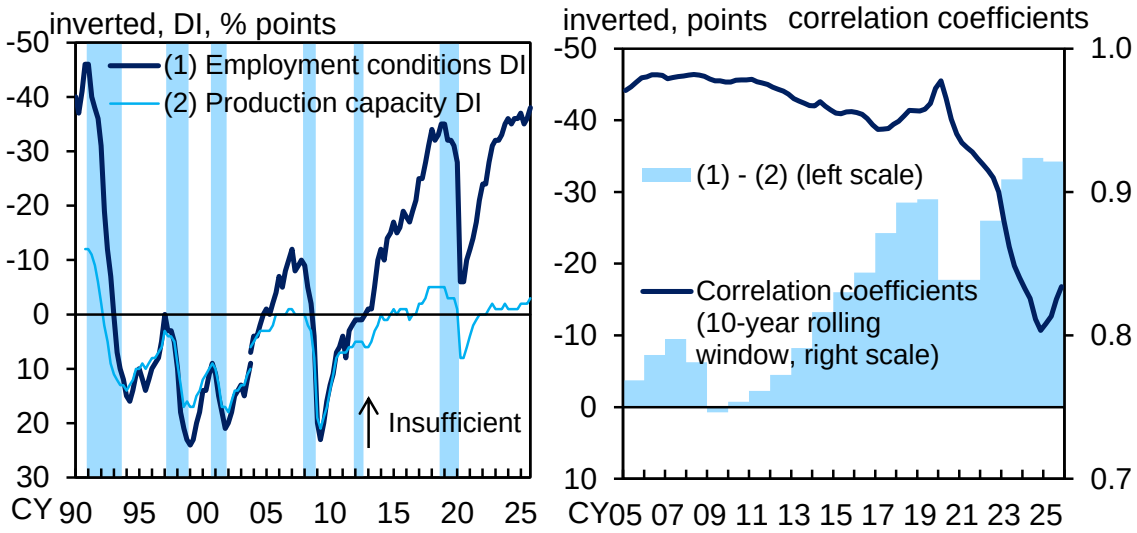
elderly. Third, we have changed the hours worked gap estimation to better capture recent developments such as the progress of work-style reforms as more structural trend changes. Meanwhile, the potential growth rate has also been re-estimated using the 2020 base-year GDP and capital stock statistics, through the calculation of the total factor productivity growth rate.

In order to assess economic and price developments, using estimates of the output gap to identify the aggregate supply and demand balance remains critical. However, in recent years, and amid intensifying labor supply constraints, developments in labor input and labor market tightness appear to exert an increasingly significant influence on economic activity in labor-intensive sectors and price trends. In fact, the employment conditions DI (Diffusion Index), which constitutes the *Tankan* factor utilization index and which is released regularly alongside the output gap, has recently marked the highest net "insufficient employment" level since 1991, while the production capacity DI remains at the low level of "insufficient." This suggests the possibility that, unlike in previous labor shortage phases, recent tightness in labor market conditions can be attributed not only to an expansion in aggregate demand, which affects both DIs, but also to factors that are specific to labor supply (Chart 1). Such strengthening of labor supply constraints indicates that, particularly in labor-intensive sectors where substitution between labor and capital is low (and therefore where it is difficult to compensate for labor shortages with an increase in capital stock), economic activity is constrained and upward pressure on wages and prices may be higher than suggested by the output gap alone.[3] Against this backdrop, this paper also conducts a brief empirical performance exercise of labor market indicators that are considered to be suitable for complementary monitoring of the output gap, given their relevance to forecasting wages and prices.

[3] In estimating the output gap, it is assumed that, from a macro perspective under a Cobb-Douglas production function, a certain degree of substitution is possible between labor and capital (the elasticity of substitution between the two is 1). However, in labor-intensive sectors, the elasticity of substitution is considered to be lower than 1. For details on these discussions, see Box 2 of the January 2025 *Outlook for Economic Activity and Prices* (Bank of Japan, 2025).

Chart 1. Employment Conditions DI and Production Capacity DI

(1) Developments over Time **(2) Correlation Coefficients**



Notes: 1. Based on the *Tankan*. All industries and enterprises. There is a discontinuity in the data for December 2003 due to a change in the survey framework.
2. In the left-hand chart, shaded areas denote recession periods.
Source: Bank of Japan.

The remainder of this paper is organized as follows: Chapter 2 explains the details of the revision to the output gap and potential growth rate. Chapter 3 outlines the characteristics of various labor market indicators and empirically examines which indicators are useful as complements to the output gap for wage and price forecasts. Chapter 4 concludes.

BOX: Examples of Macro Supply-Demand Indicators by Other Institutions

Many other central banks maintain analytical frameworks to capture the aggregate supply-demand balance when assessing economic and price conditions. In particular, the output gap, which shows the utilization of not only labor but also capital as production factors, is used by many central banks as an indicator of the aggregate supply-demand balance and pressure on prices and wages (Box Chart).[4] However, it is also noted that output gaps involve estimation uncertainties and ex-post revisions when data is updated (See, for example, ECB (2025), Bank of Canada (2026), and Fukunaga et al. (2024)).

[4] The Federal Reserve (FRB) in the United States estimates the output gap in its staff reports (Tealbook) submitted to the FOMC for monetary policy discussions (which are released to the public five years after the FOMC meeting) and utilizes them for internal assessments of conditions. Similarly, the European Central Bank (ECB) mentions the usefulness of output gap indicators in its Monetary Policy Strategy Review (ECB, 2025).

(BOX Chart) Examples of Macro Supply-Demand Indicators by Central Banks

	Use of output gap	Supply-demand indicators presented to the public (e.g., statements, monetary policy reports)
FRB (US)	○ (Mainly for internal use)	Unemployment rate; unemployment rate gap; labor force participation rate; separation rate; VU ratio, etc.
ECB (Euro area)	○ (References in the Monetary Policy Strategy Review)	Unemployment rate; long-term unemployment (% of labor force); unemployment rate (youth, male, and female), etc.
BOE (UK)	◎	Output gap; capital utilization rate; VU ratio; labor turnover ratio, etc.
BOC (Canada)	◎	Output gap; unemployment rate; labor force participation rate; intensity of labor shortages (balance of opinion, *Business Outlook Survey*), etc.
RBA (Australia)	◎	Output gap; unemployment rate; labor force participation rate; employment rate; capital utilization rate, etc.
RBNZ (New Zealand)	◎	Output gap; unemployment rate; hours worked gap; capital utilization rate; VU ratio, etc.

Considering these estimation uncertainties, comprehensively evaluating the supply-demand environment using various related indicators in addition to the output gap (indicator suite) is a practice widely shared among many central banks. Specifically, labor market indicators (unemployment rate, unemployment rate gap, job openings/quits rate indicators, etc.) and indicators that capture supply and demand imbalances on the firm-side (capital utilization rate, survey indicators, etc.) are utilized, depending on the economic structure and data availability of each country. Many central banks monitor these indicators on a continuous basis in their monetary policy reports and statements, and utilize them to assess the economic activities and prices.

2. Updates on the Output Gap and Potential Growth Rate[5]

2-1. Revision of the Labor Input Gap

The labor input gap is calculated as the sum of the labor force participation rate gap, the employment rate gap, and the hours worked gap.

(1) Labor Force Participation Rate Gap

Looking at the labor force participation rate, it has fluctuated due to both structural factors, such as changes in lifestyle and working styles, and cyclical factors, such as the specific economic conditions at each point in time. Since the early 2010s, the trend has turned clearly upward, reflecting the progress of labor participation by women and the elderly. Taking these factors into account, the 2017 revision adopted a piecewise linear regression method that allowed trend kinks at the peaks of the business cycle so that the steep rise in the labor force participation rate could be recognized as a change in trend.

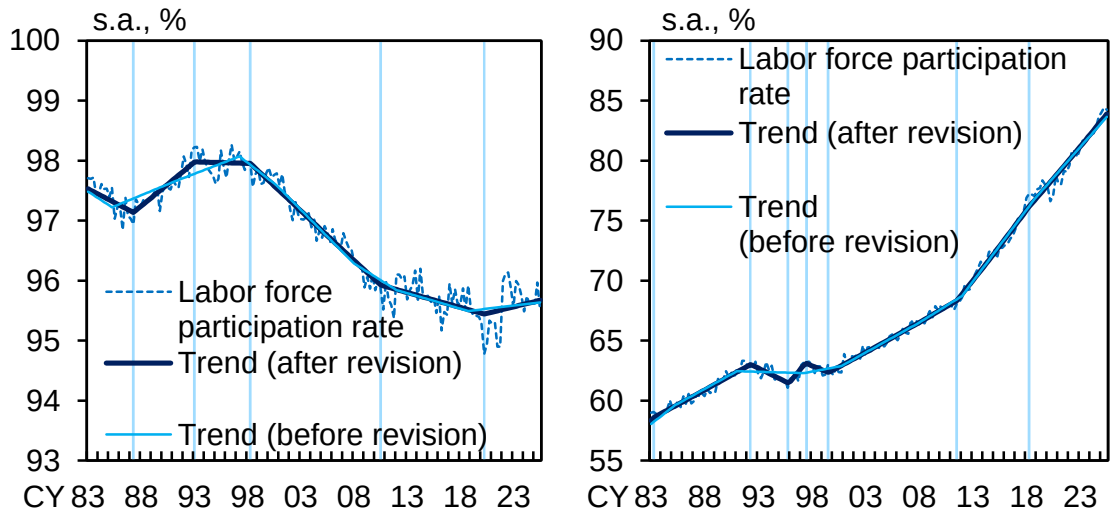
However, looking by gender and age group, for some groups, structural changes in the trend (e.g., retirement age extensions) occur at timings irrelevant to business cycles. Therefore, in this revision, the methodology of Muggeo (2003), which automatically detects kinks in the linear trend based on actual data independent of business cycles, is adopted for each gender and age group.[6] Looking at the results, for age groups with high labor participation rates (ages 30s to 40s), the structural breakpoints detected from the data are roughly consistent with the timing of the business cycle; thus, there is no significant change in the trend from the previous method (Chart 2). In contrast, for the labor force participation rate of older age groups, which are susceptible to institutional changes such as retirement age extensions, differences are observed between the trends detected before and after the revision, particularly for males (Chart 3).

[5] The basic concept behind the output gap and potential growth rate estimated by the Research and Statistics Department remains unchanged even after this revision; therefore, detailed explanations are omitted here. For details, see Chapter 2 of Kawamoto et al. (2017).

[6] For specific estimation methodologies, see Annex 1.

Chart 2. Examples of Changes in Labor Force Participation Rate Trends Consistent with Business Cycle

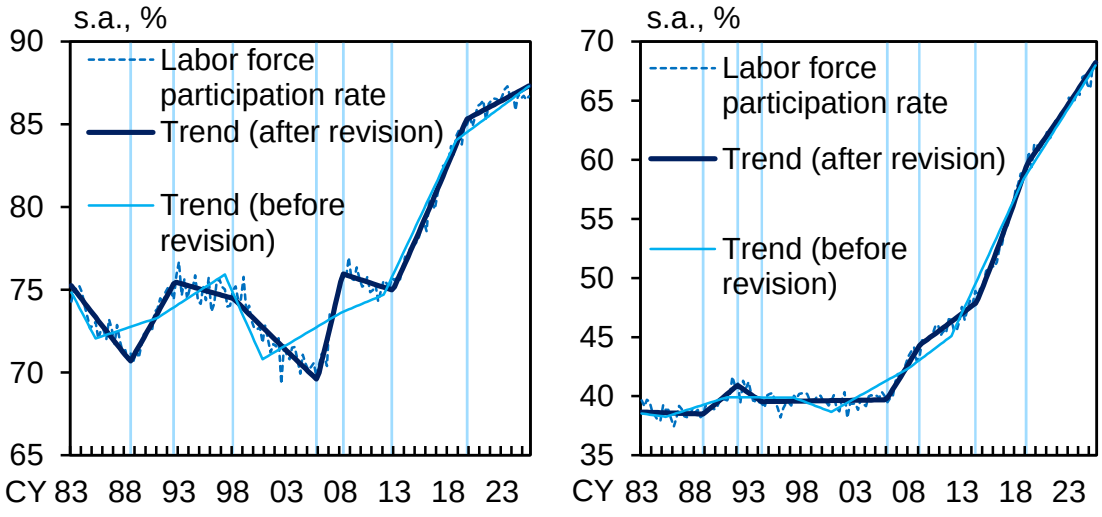
(1) Male, 30-44 years old **(2) Female, 30-44 years old**



Note: Vertical lines denote the structural breakpoints detected with data.
Source: Ministry of Internal Affairs and Communications.

Chart 3. Examples of Changes in Labor Force Participation Rate Trends Independent of Business Cycle

(1) Male, 60-64 years old **(2) Female, 60-64 years old**

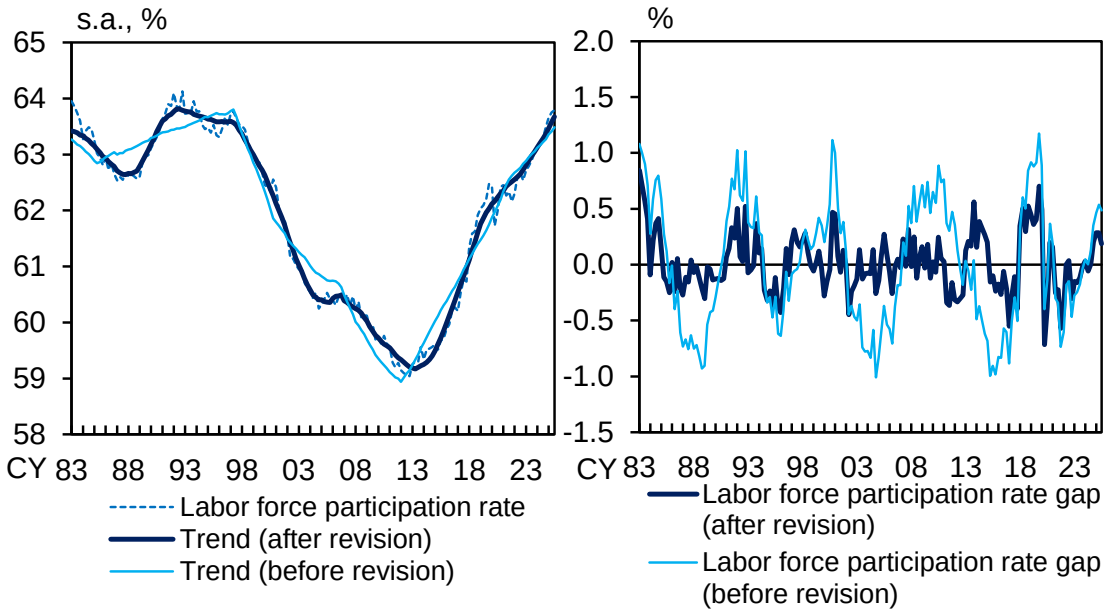


Note: Vertical lines denote the structural breakpoints detected with data.
Source: Ministry of Internal Affairs and Communications.

The revision is able to capture trend changes in each group more flexibly. As a result, comparing the overall trend of the labor force participation rate, the revised trend follows the actual labor force participation rate more closely, and thereby, the fluctuation of the revised labor force participation rate gap is smaller than before (Chart 4).[7]

Chart 4. Revision of Labor Force Participation Rate Trend and Gap

(1) Labor Force Participation Trend **(2) Labor Force Participation Gap**



Source: Ministry of Internal Affairs and Communications.

(2) Employment Rate Gap

In this revision, we have revised the vacancy rate data used for estimating the structural unemployment rate, and the estimation period for the relationship between the vacancy rate and the unemployment rate (Beveridge curve) has been reviewed.[8] Regarding vacancy rate data, there is some debate as to whether effective job openings data in the *Employment Referral Statistics* are understated, due to the recent shift from the use of the Public Employment Security Office to the use of private employment agencies.[9] In this

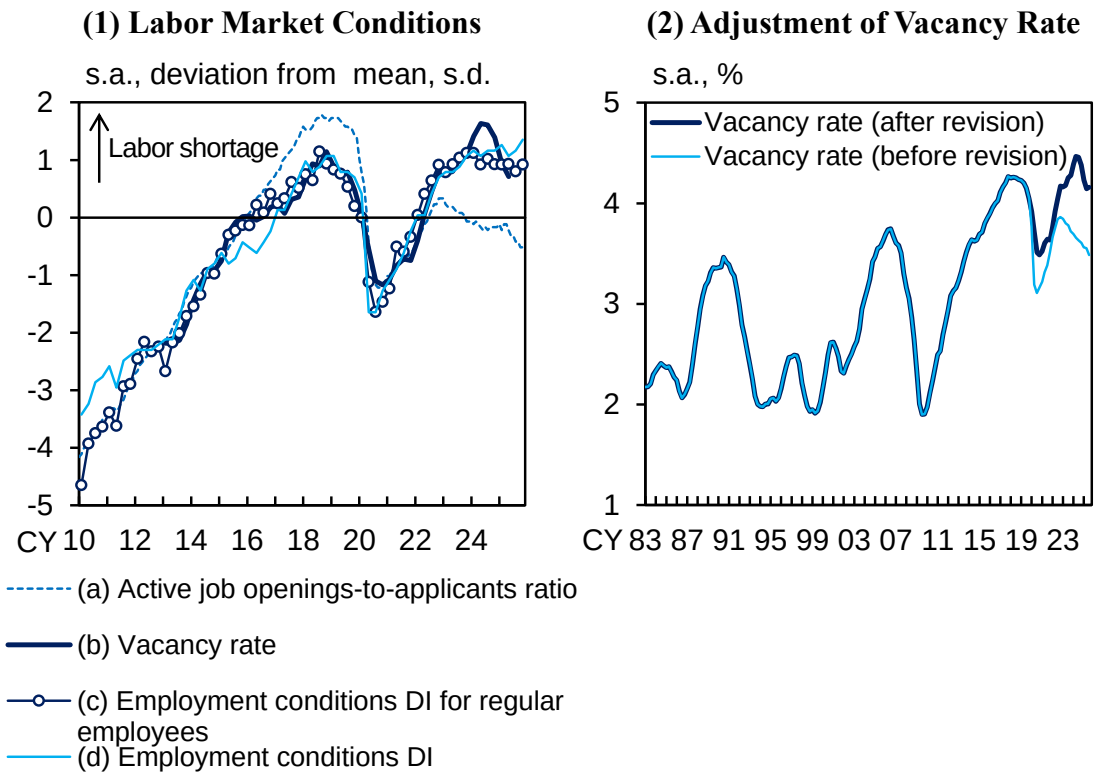
[7] Taking the labor force participation rate for those ages 60–64 as an example, trend changes can be observed at timings such as the enforcement of the "Act on Stabilization of Employment of Elderly Persons" in the late 1980s, the introduction of measures to secure employment until age 65 in 2006, and the introduction of measures to secure employment for all applicants until age 65 in 2013.

[8] In addition, since the number of effective job openings by age group from September 2020 onward became unavailable, the estimation is changed to be based on all age groups rather than by age group.

[9] Cabinet Office (2025) points out that the active job openings-to-applicants ratio in the *Employment*

revision, for the period from 2020 onward, when the discrepancy between effective job openings in the *Employment Referral Statistics* and private agencies has increased, the vacancy rate has been adjusted using unfulfilled job openings (vacancies) and the DI for employment conditions for regular employees from the *Survey on Labour Economy Trend* (Chart 5).[10]

Chart 5. Assessing Labor Market Conditions



Notes: 1. In the left-hand chart figures are standardized with mean and standard deviation from 2013. Figures for vacancy rate are 2-quarter backward moving averages.
2. The data source for (a) is the *Employment Referral Statistics*, those for (b) and (c) are the *Survey on Labour Economy Trend*, and that for (d) is the *Tankan*.
Sources: Ministry of Health, Labour and Welfare; Bank of Japan; Ministry of Internal Affairs and Communications.

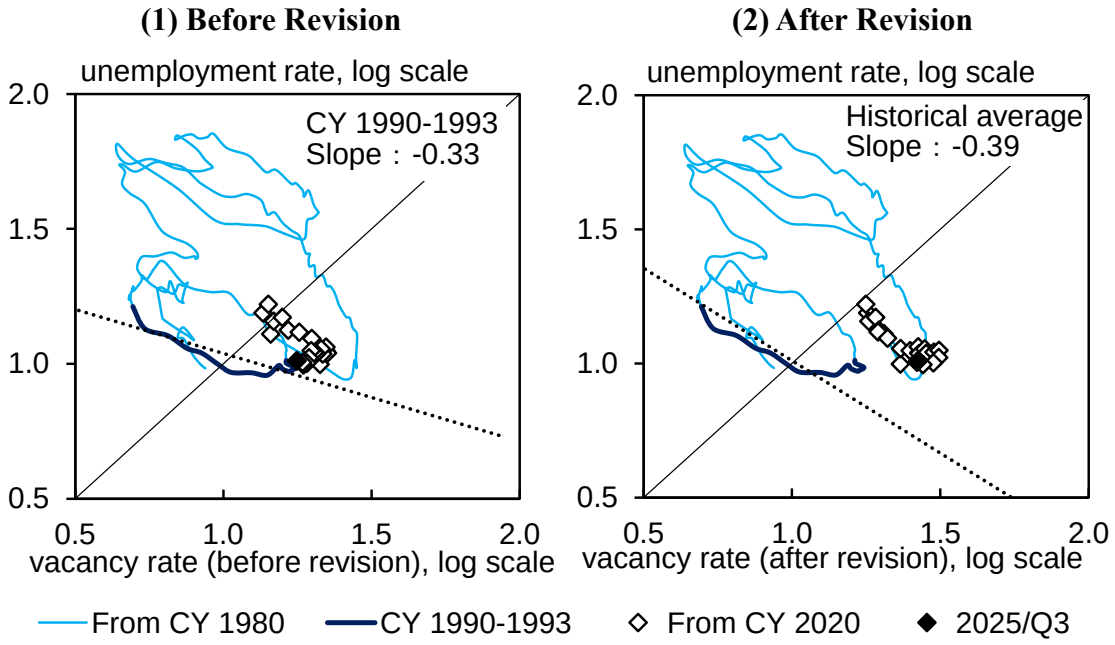
Furthermore, regarding the estimation of the Beveridge curve (UV curve), structural unemployment was defined as the point on the 45-degree line using the slope from 1990–

Referral Statistics has been less useful for evaluating the tightness of labor supply and demand.

[10] Specifically, (1) for the period from 2013 to 2021, the vacancy rate calculated based on the number of effective job openings in the *Employment Referral Statistics* is regressed on the vacancy rate in the *Survey on Labour Economy Trend*, and (2) for 2020 onward, the predicted values obtained from that estimation are used as the vacancy rate. Note that since the release of the vacancy rate in the *Survey on Labour Economy Trend* was suspended after the April–June 2025 survey, data for the July–September 2025 onward are extrapolated using the DI for employment conditions for regular employees from the *Survey on Labour Economy Trend*.

1993, when the relationship was relatively clear.[11] However, more than 30 years have passed since 1990–1993, and there is the possibility of various structural changes occurring in the labor market. Thus, following Michaillat and Saez (2021), we firstly calculate the historical average slope of UV curve, then define the intersection of this slope and the 45-degree line as the structural unemployment rate for each period while allowing for shifts in the UV curve's interception due to changes in matching efficiency and other factors (Chart 6).[12]

Chart 6. Beveridge Curve



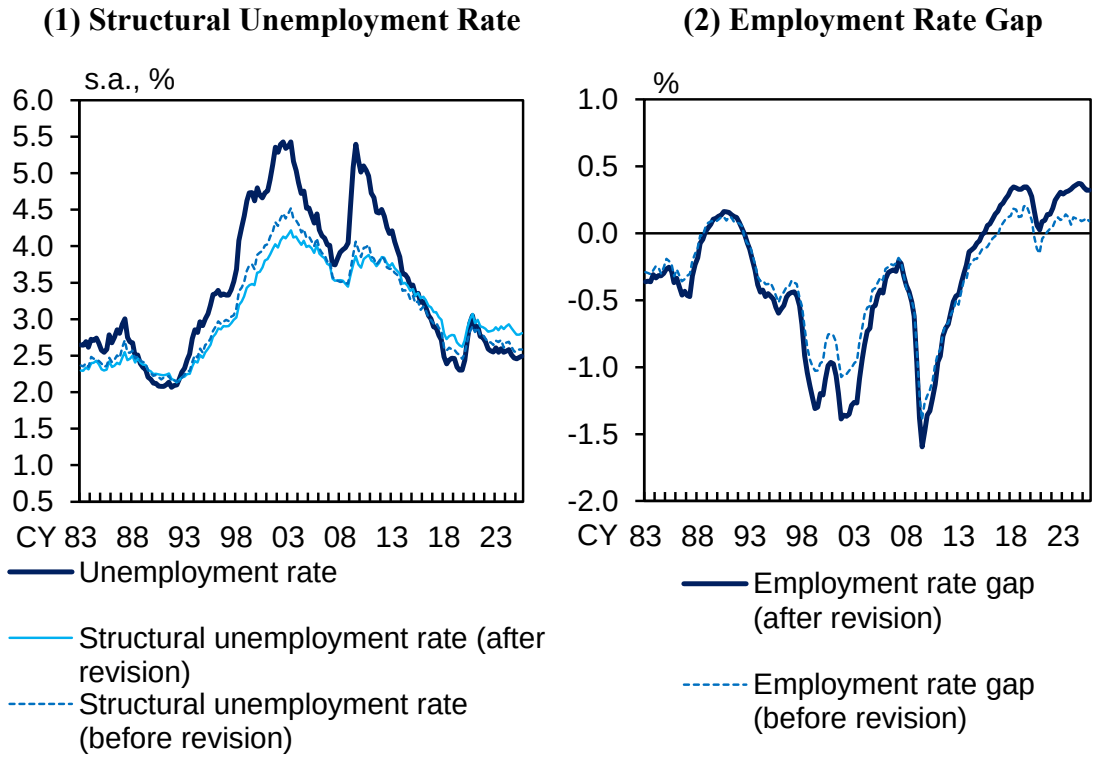
Sources: Ministry of Health, Labour and Welfare; Ministry of Internal Affairs and Communications.

As a result, the estimated structural unemployment rate is higher than previous estimates since the 2010s, suggesting that labor market mismatches may have expanded during this period. Therefore, the employment rate gap, measured as the difference between the actual unemployment rate and the estimated structural unemployment rate, has been revised upward since the 2010s, indicating that labor market conditions have remained tighter during this period (Chart 7).

[11] In UV analysis, the unemployment rate is defined not as number of unemployed / number of labor force but as the rate defined as number of unemployed / (number of employees + number of unemployed). This is because the denominator of the unemployment rate includes self-employed persons and family workers, whereas the denominator of the vacancy rate (number of vacancies / (number of employees + number of vacancies)) does not include workers such as self-employed persons.

[12] Regarding changes in the interception in the revised UV curve estimation, see Annex 2.

Chart 7. Structural Unemployment Rate and Employment Rate Gap: Before and After revision



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

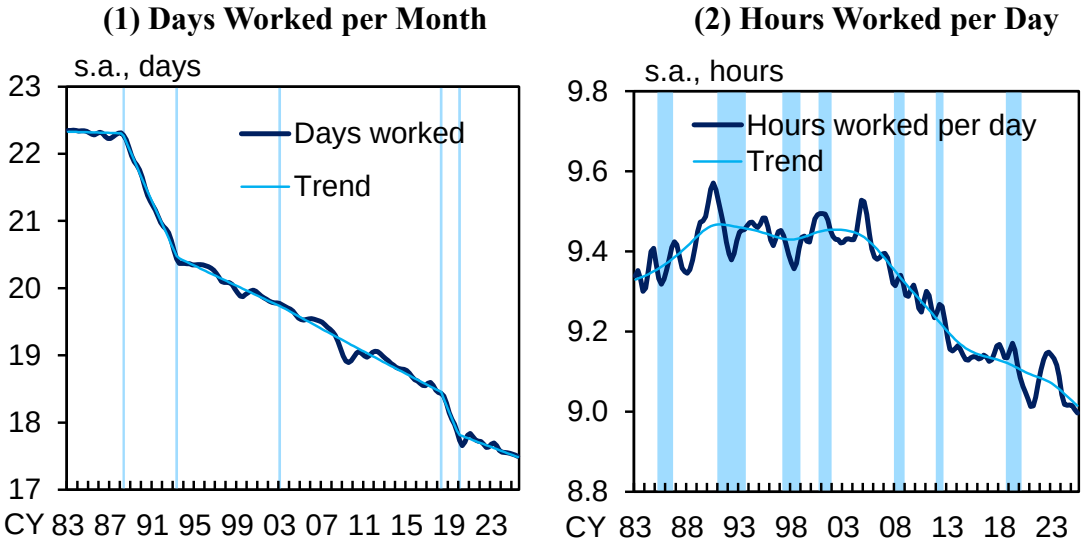
(3) Hours Worked Gap

Regarding potential hours worked (the labor hour trend), previously trend components were extracted using HP filters for total hours worked from the *Monthly Labour Survey* for full-time and part-time workers separately, and then these were weighted by the part-time worker ratio. However, since the survey captures hours worked from the firm side for regular employees (comprising employees with indefinite-term contracts and those with fixed-term contracts of one month or more), it might not fully capture the impact of the diversification of work arrangements in recent years, including expansion of side jobs, spread of spot and gig work, and so on. Furthermore, the previous method could not fully track large structural declines in hours worked (around 1990 and 2019) as trends, and as a result, some of these changes were captured as cyclical declines (deterioration of the hours worked gap).

In this revision, first, the data source for total hours worked was changed to the *Labour Force Survey*, which surveys households and is considered relatively more likely

to capture the effects of work style diversification. On top of that, the trend extraction method was modified by dividing total hours worked into days worked and hours worked per day.[13] For the former, days worked, the piecewise linear regression method was applied to the days worked from the *Monthly Labour Survey* to estimate the trend, taking into account that trend kinks due to institutional factors, such as the weekly work day regulation and mandatory annual leave, are relatively easy to detect.[14] For the latter, hours worked per day, the HP filter continues to be applied to estimate the trend (Chart 8).

Chart 8. Hours Worked Trend: After Revision

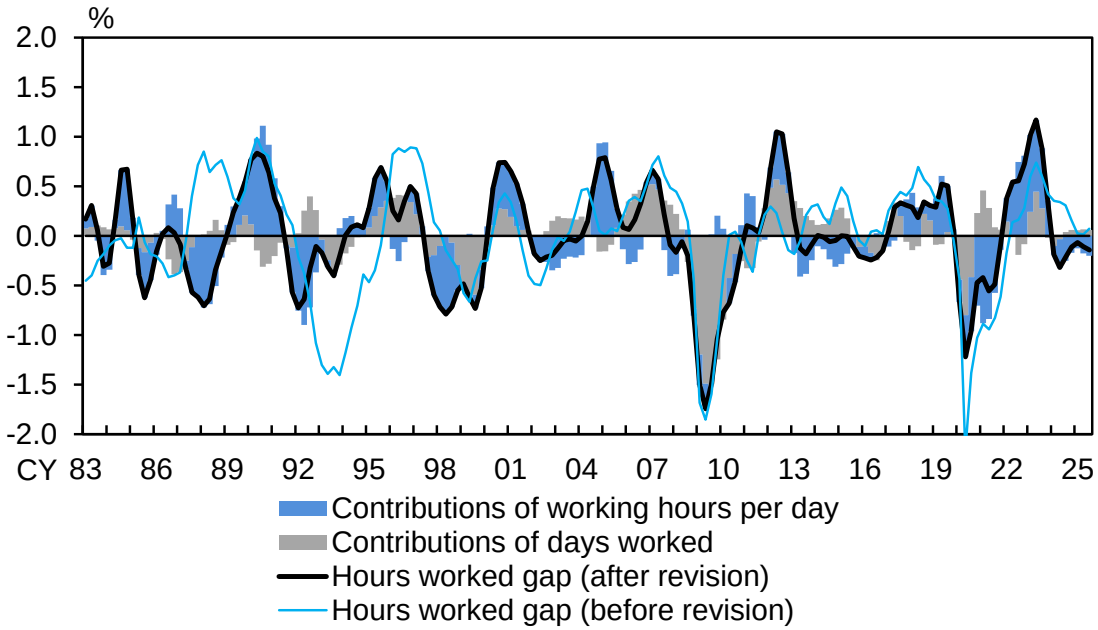


Note: Vertical lines in the left-hand chart denote estimated structural break points.
Shaded areas in the right-hand chart denote recession periods.
Sources: Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare.

Comparing the hours worked gap before and after the revision (Chart 9), the negative gap is smaller around 1990 and 2020. This is likely because the decline in days worked due to institutional factors is recognized as a trend change more quickly than with the previous method using HP filter.

[13] For days worked and hours worked per day, the values excluding irregular fluctuations (the trend-cycle component of X-12-ARIMA) are used.
[14] Regarding changes in the environment surrounding hours worked, see Annex 3. Note that in principle, the *Labour Force Survey* asks households about their working hours during the last week of the month. Since it is known that working hours fluctuate according to the number of holidays included in that week, caution is required when converting them into monthly working hours (e.g., Genda, 1993). In this revision, to address such fluctuations in working hours, the holiday factor was adjusted through regression analysis based on the relationship between the number of weekdays and working hours in the last week of the month in the past.

Chart 9. Hours Worked Gap: Before and After Revision



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

2-2. Revision of the Capital Input Gap

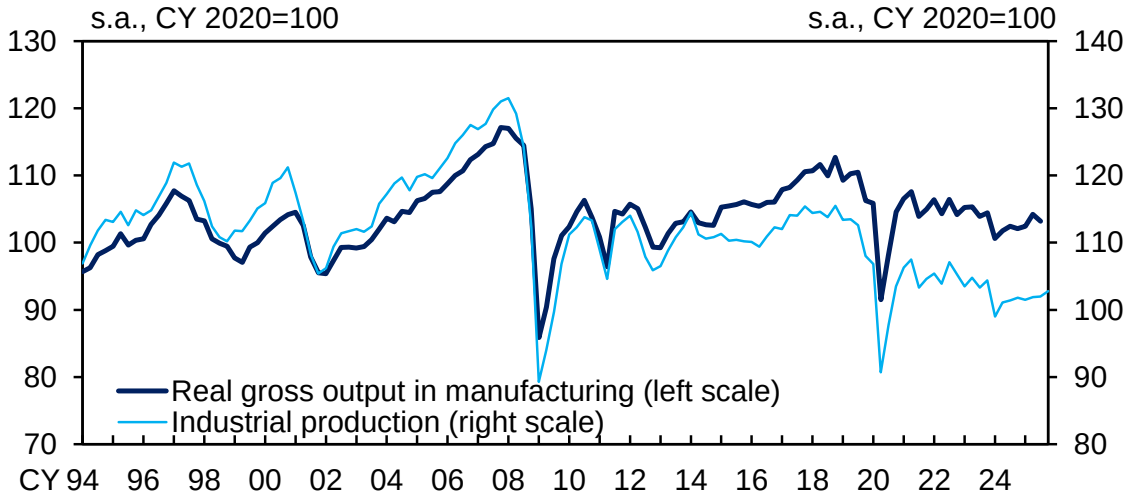
(1) Manufacturing Utilization Gap

Regarding the manufacturing utilization rate (= output / production capacity), while previously the denominator (production capacity) used a value-added basis[15] value by correcting the Indices of Production Capacity based on SNA Capital Stock Statistics, the numerator (output) used the Indices of Industrial Production (IIP), which is largely measured on a quantity basis. The manufacturing utilization gap has been estimated as the deviation rate from its long-run average, but since the production index is quantity-based, it failed to capture the recent increase in the value-added basis, and as a result, the manufacturing utilization rate was prone to downward bias (Chart 10).[16]

[15] The term "value-added basis" used in this paper is synonymous with "taking into account fluctuations in real output due to changes in quality."

[16] Approximately 90 percent of the items in the IIP are quantity indices that use weight or number of units as measurement units. For this reason, it has been pointed out that quality improvements in machinery and other goods are not fully reflected in the index, leading to a downward bias compared to value-added based indices that account for quality improvements (Higo, 2025).

Chart 10. Comparison of Manufacturing Production Levels



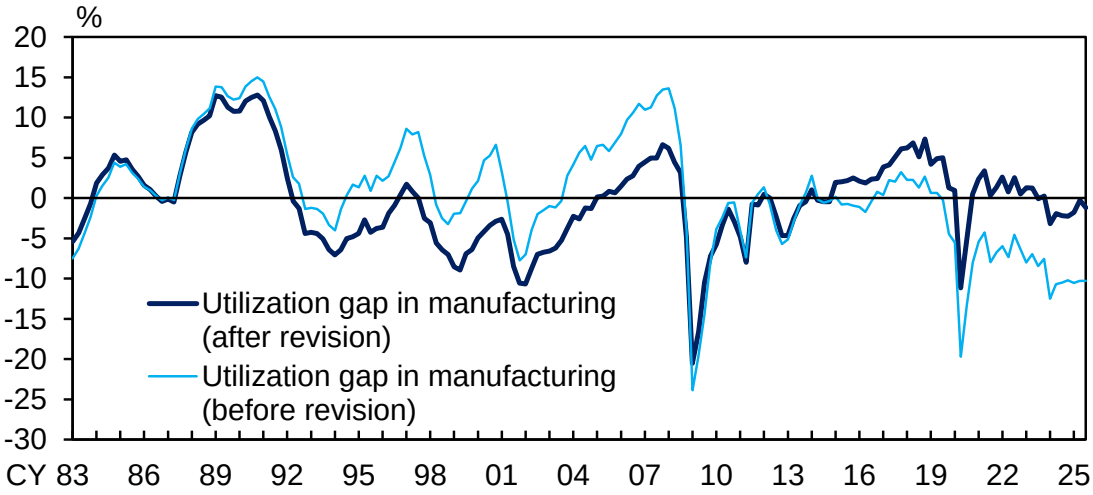
Sources: Cabinet Office; Ministry of Economy, Trade and Industry.

Owing to recent improvements in statistics, the quarterly national accounts (QNA) for value added from the production side have been available since 2022, making it possible to capture production at the value-added level. Therefore, in this revision, QNA for value added from the production side is used for the output in calculating the manufacturing utilization rate.[17] Specifically, after regressing the IIP on the real output of QNA for value added from the production side, those estimated values were used for the numerator of manufacturing utilization.

The new manufacturing utilization gap is revised upward since the 2010s, and the magnitude of revision increases toward the most recent period (Chart 11). This is thought to reflect that while production of commodity products with relatively low value-added shifted overseas since the 2010s, the weight of high-value-added goods production increased domestically; therefore, from a value-added perspective, the capital utilization rate has not declined as much as suggested by the quantity-based figures.

[17] On the other hand, as also pointed out by Higo (2025), the IIP has advantages such as enabling rapid responses from firms by adopting quantity units like weight or number of units, and having smaller fluctuations in figures compared to real values calculated by dividing production/shipment amounts by a price index. Since the release of the QNA for value added from the production side is usually delayed by more than one month from the release of the second preliminary GDP (2nd QE), the growth rate of the IIP—which is released earlier—is used for the most recent quarter.

Chart 11. Utilization Gap in Manufacturing: Before and After Revision



Sources: Cabinet Office; Ministry of Economy, Trade and Industry.

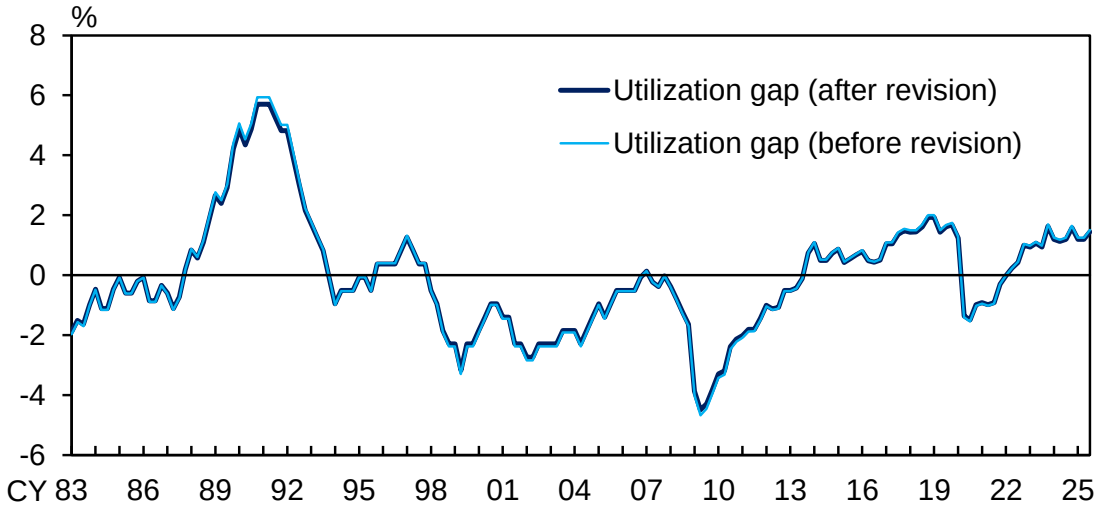
(2) Nonmanufacturing Utilization Gap

Since actual utilization data does not exist for nonmanufacturing sectors in Japan, the *Tankan* Production Capacity DI is used to estimate utilization.

In this revision, the regression model was modified to capture the correspondence between the manufacturing utilization rate and its DI and the (unobservable) nonmanufacturing utilization rate and its DI. Those parameters for manufacturing were then used to convert the nonmanufacturing DI into the same scale as manufacturing.[18] The nonmanufacturing utilization gap shows only small changes after the revision (Chart 12).

[18] Previously, the relationship between manufacturing utilization rate and the *Tankan* production capacity DI for nonmanufacturing was estimated directly with a regression formula, and the predicted values were used as nonmanufacturing utilization rate. In this revision, (1) after estimating a regression formula with manufacturing utilization rate as the dependent variable and the *Tankan* production capacity DI for manufacturing as the explanatory variable, (2) nonmanufacturing utilization rate is estimated from the *Tankan* production capacity DI for nonmanufacturing using those parameters, and (3) the deviation from its long-term average is defined as the nonmanufacturing utilization gap.

Chart 12. Utilization Gap in Nonmanufacturing: Before and After Revision

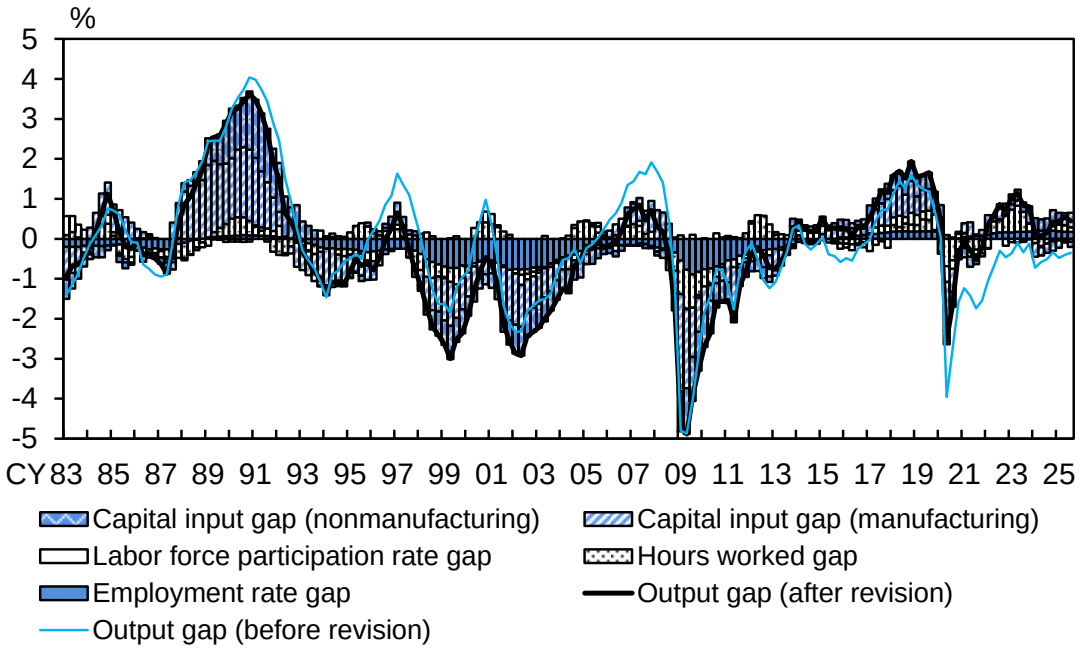


Sources: Cabinet Office; Ministry of Economy, Trade and Industry; Bank of Japan.

2-3. Revised Output Gap

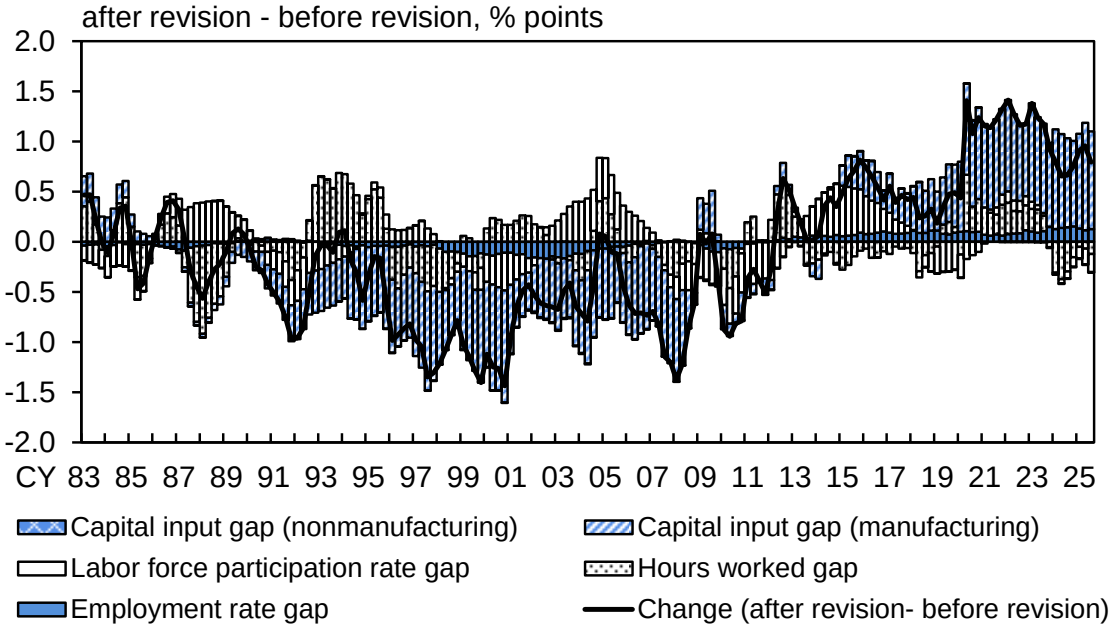
Looking at the revised output gap (Charts 13, 14), there is no significant change in the overall shape compared to that of the previous method, and the timing of peaks and troughs also remains roughly unchanged. On the other hand, since around 2023, the output gap has been revised upward from near-zero to a small positive value, mainly reflecting upward revisions in the manufacturing capital input gap and the employment rate gap.

Chart 13. Output Gap: Before and After Revision



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

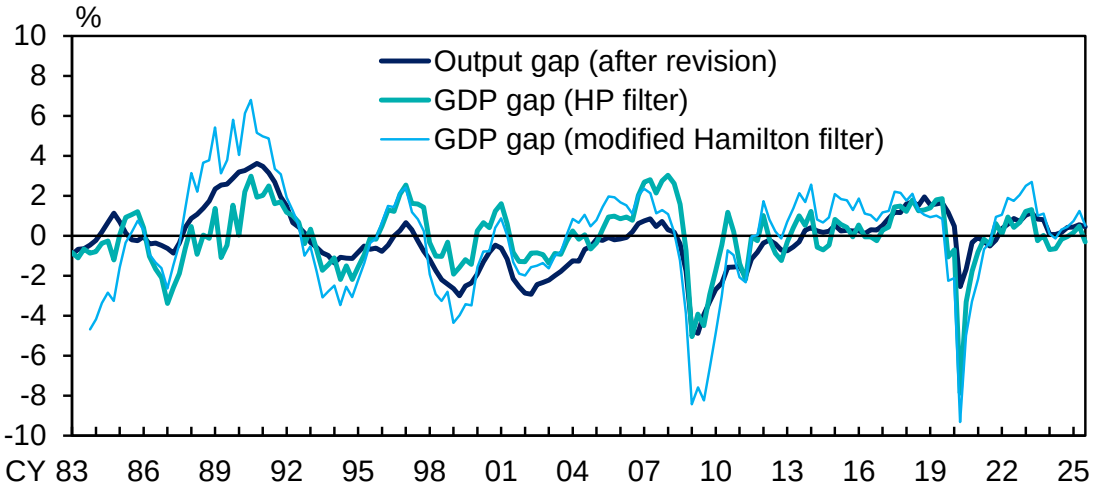
Chart 14. Difference between the Output Gap Before and After Revision



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

Comparing the revised output gap with gaps calculated by simply filtering GDP or with estimates from other institutions (Charts 15, 16),[19] while the movements corresponding to business cycles are similar as a whole, significant discrepancies exist in certain phases.[20] Each output gap is based on a different approach, and there are also differences in data and estimation methods used, and the estimation periods applied. Discrepancies between estimates from different approaches indicate that measurement involves a degree of uncertainty, suggesting that the estimates in this paper should also be interpreted with a certain latitude.

Chart 15. Comparison with Estimates of Japan's Output Gap by Filtering Approach

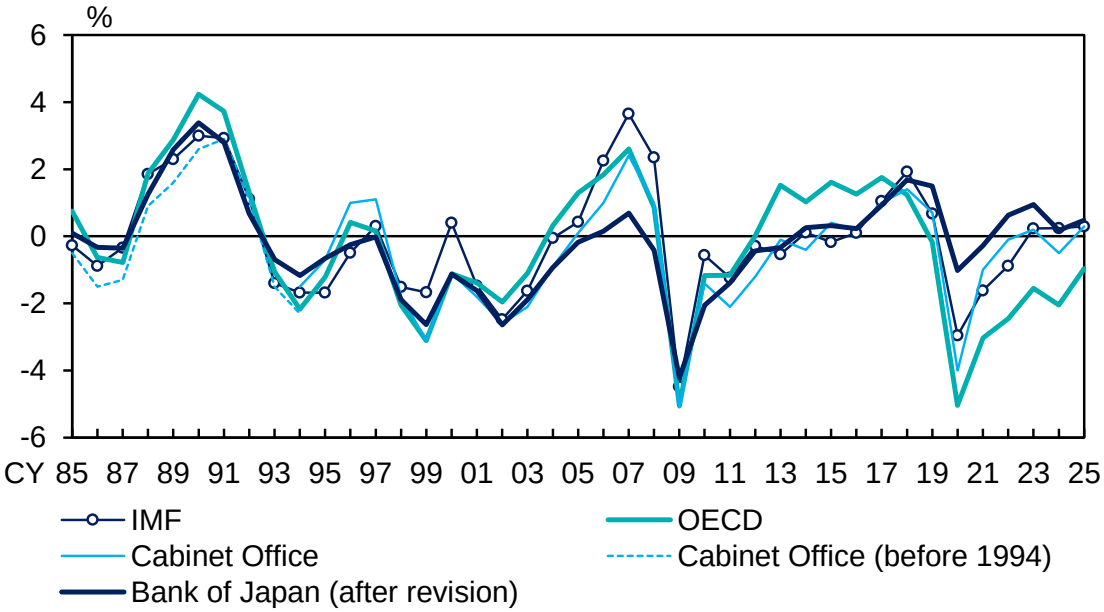


Sources: Cabinet Office; Bank of Japan.

[19] GDP gaps in Chart 15 are calculated by applying the representative filtering methods, the HP filter and the modified Hamilton filter, to GDP. The gap based on the HP filter is calculated as the deviation rate of actual GDP from the trend estimated using the HP filter (λ = 1,600). The gap based on the modified Hamilton filter is calculated as the deviation rate of actual GDP from the trend defined as the average of predicted values for the future (4 to 12 quarters ahead) of GDP using a regression formula with past lag terms as explanatory variables. The modified Hamilton filter has the advantage of being less susceptible to the "endpoint problem"—where the estimated trend component is easily affected by recent data—which occurs with the HP filter. For details on the Hamilton filter, see Hamilton (2018) and Quast and Wolters (2022).

[20] Looking at the estimation methods of each institution, the IMF (De Masi, 1997; IMF, 2023, 2025) adopts an approach of estimating the output gap first from the utilization of capital and labor, similar to the Research and Statistics Department of the Bank of Japan. In contrast, the Cabinet Office (Yoshida, 2017; Cabinet Office, 2023, 2026) and the OECD (Giorno et al., 1995; Cotis et al., 2005; Beffy et al., 2006; Chalaux and Guillemette, 2019; OECD, 2025) adopt an approach of estimating potential GDP first and then obtaining the output gap by subtracting it from actual GDP.

Chart 16. Comparison with Estimates of Japan's Output Gap from Other Institutions



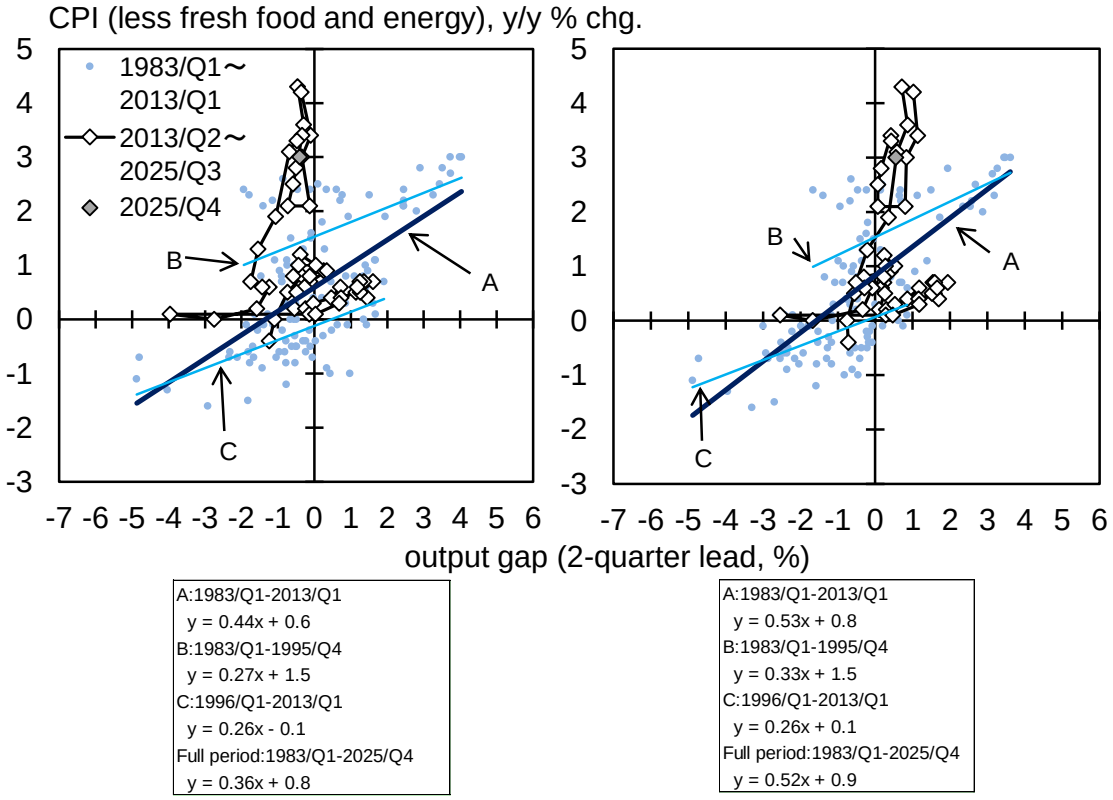
Notes: 1. Figures for the IMF are based on the October 2025 "World Economic Outlook." Figures for the OECD are based on the December 2025 "Economic Outlook." Figures for 2025 are each institution's projections. Figures for the IMF and OECD are those prior to the benchmark year revision of 2020 in GDP statistics.
2. Figures for the Cabinet Office before 1994 are those prior to the benchmark year revision of GDP statistics.
3. The figure for the Bank of Japan for 2025 is Q1-Q3 average.
Sources: IMF; OECD; Cabinet Office; Bank of Japan.

2-4. Relationship with Consumer Prices (Phillips Curve)

Comparing the relationship between the output gap and consumer prices (Phillips curve) before and after the revision (Chart 17), the overall shape of the simple linear regression remains roughly unchanged, however the slope appears to have become somewhat steeper after this revision. Furthermore, using a hybrid Phillips curve specification that controls for changes in both backward-looking and forward-looking inflation expectations (Chart 18), the fit of the model (adjusted R^2 or S.E. of regression) is roughly unchanged, however the parameter for the output gap is somewhat larger and its statistical significance has also slightly improved. The above simple empirical results show that the relationship between the output gap and consumer prices has become somewhat clearer due to this revision.

Chart 17. Phillips Curve

(1) Before Revision **(2) After Revision**



(1) Before Revision	(2) After Revision
A:1983/Q1-2013/Q1 y = 0.44x + 0.6	A:1983/Q1-2013/Q1 y = 0.53x + 0.8
B:1983/Q1-1995/Q4 y = 0.27x + 1.5	B:1983/Q1-1995/Q4 y = 0.33x + 1.5
C:1996/Q1-2013/Q1 y = 0.26x - 0.1	C:1996/Q1-2013/Q1 y = 0.26x + 0.1
Full period:1983/Q1-2025/Q4 y = 0.36x + 0.8	Full period:1983/Q1-2025/Q4 y = 0.52x + 0.9

Note: CPI figures are staff estimates and exclude mobile phone charges and the effects of consumption tax rate changes, policies concerning the provision of free education, and travel subsidy programs.
Sources: Ministry of Internal Affairs and Communications; Bank of Japan.

Chart 18. Performance Comparison of Previous and Revised Output Gaps: Phillips Curve

(1) Specification

CPI less fresh food and energy (s.a., ann., q/q % chg.)$_t$
$=\beta_0$
$+\beta_1 \times$ (medium- to long-term inflation expectations$_t$)
$+\beta_2 \times$ (CPI less fresh food and energy$_{t-1}$)
$+(1-\beta_1-\beta_2) \times$ (CPI less fresh food and energy$_{t-2}$)
$+\beta_3 \times$ (output gap$_t$)
$+\beta_4 \times$ (dummy variables for special factors)

[Estimation Period]
1990/Q1-2025/Q3

(2) Estimation Results

	Before revision	After revision
β_0	-0.09	-0.10 *
β_1	0.14 ***	0.20 ***
β_2	0.67 ***	0.62 ***
β_3	0.08 **	0.13 ***
Adjusted R^2	0.81	0.82
S.E. of regression	0.15	0.14

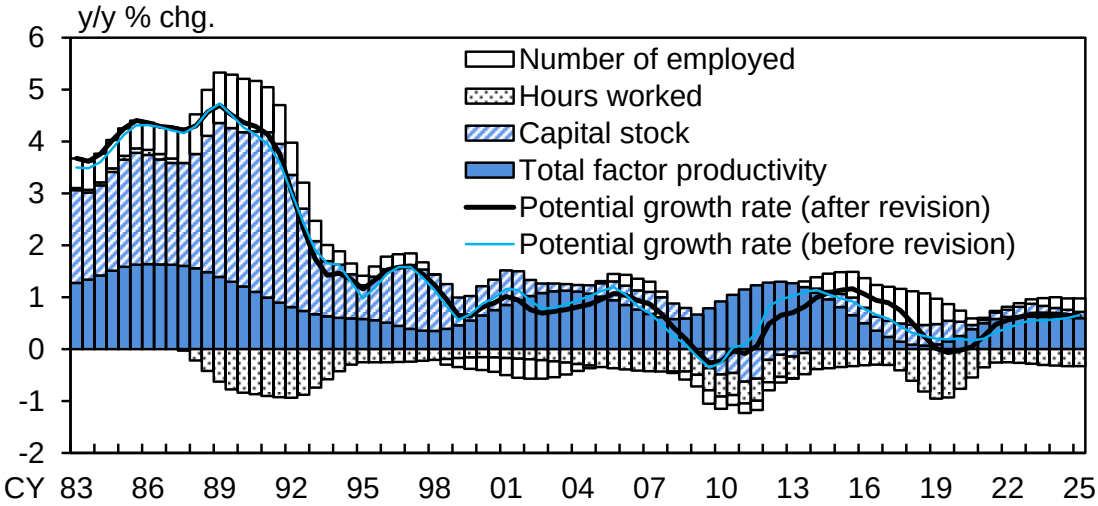
Note: CPI figures are staff estimates and exclude mobile phone charges and the effects of consumption tax changes, policies concerning the provision of free education, and travel subsidy programs. Medium- to long-term inflation expectations are based on the consensus forecast (CF) for the period before 2014, and for 2014 and beyond, they are calculated as a weighted average using the inverse of the standard deviation of six indicators (*Tankan*, CF, ESP Forecast, QUICK, and the Opinion Survey on the General Public's Views and Behavior <qualitative and quantitative>) as weights. Dummy variables are included in order to control for the estimate effects of special factors such as the introduction of a subsidy for high school tuition. The S.E. of regression is calculated on a quarter-on-quarter basis. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Sources: Ministry of Internal Affairs and Communications; Bank of Japan; QUICK, "QUICK Monthly Market Survey <Bonds>"; JCER, "ESP Forecast Survey"; Consensus Economics Inc., "Consensus Forecasts."

2-5. Revised Potential Growth Rate

The potential growth rate is determined by the labor input trend, the growth of capital stock, and the total factor productivity (TFP) trend. Among these, the trend estimation method for labor input has been changed as described above. In addition, in this revision, the data used for capital stock was also changed to figures consistent with business fixed investment of the benchmark year revision of GDP statistics.[21] Potential TFP was then extracted with the same method as before, using the HP filter. Looking at the revised potential growth rate (Chart 19), there is a temporary drop during the pandemic due to a decline in the hours worked trend and potential TFP, but it has risen to around the 0.5 percent range, reflecting improvements in TFP and the accumulation of capital stock associated with increased investment; on the whole, the development is roughly the same as before the revision (Chart 20).

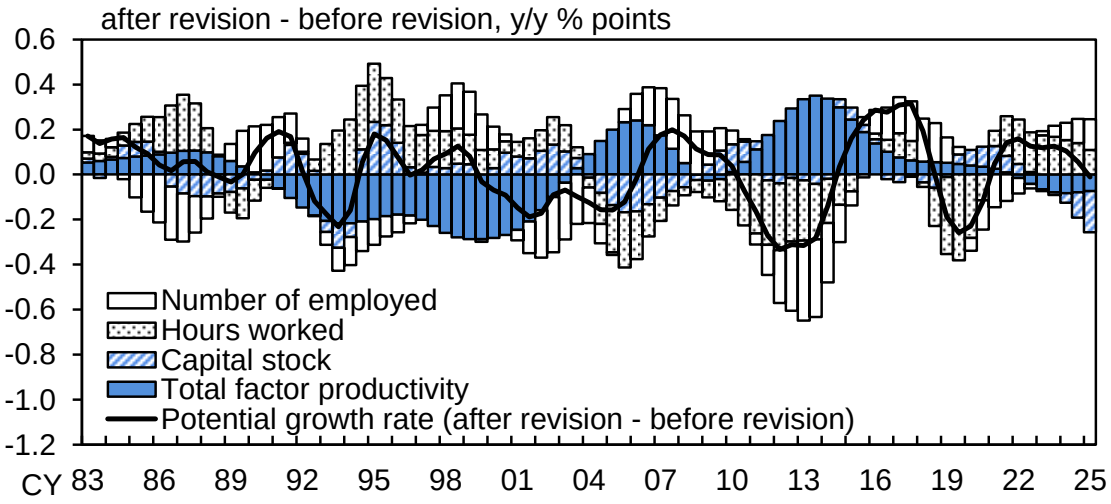
Chart 19. Potential Growth Rate: Before and After Revision



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

[21] In this revision, capital stock is changed to include that of the public enterprise sector in addition to the private corporate sector used previously. This is to ensure that discontinuities do not occur in capital stock statistics even if the operational systems of public enterprises change due to shifts in government funded amount or right to appoint directors, causing their classification in SNA statistics to shift to private enterprises. Note that even with the inclusion of public enterprises, the change in the growth rate of capital stock before and after the revision is small.

Chart 20. Differences Between the Potential Growth Rate Before and After Revision



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

3. Labor Market Indicators

Macro supply-demand balance indicators such as the output gap remain important for accurately assessing economic and price conditions. However, as stated in the Introduction of this paper, in recent years, against the backdrop of the strengthening of labor supply constraints, the impact of the supply-demand balance in the labor market on economic activity and price developments in labor-intensive sectors appears to have increased. This chapter examines which labor market indicators are appropriate for monitoring as a complement to the output gap from the perspective of their predictive power for wages and prices, while taking into account the labor market indicators referenced by central banks in other countries.

3-1. Overview of Labor Market Indicators

Chart 21 gives an overview of the potential labor market indicators for monitoring.

The unemployment rate is a primary indicator of labor market supply and demand. Furthermore, some central banks in other countries focus on the breakdown of the unemployed to refine their monitoring. This includes the short-term unemployment rate, which targets those with short durations of joblessness and is highly sensitive to cyclical economic fluctuations, as well as the long-term unemployment rate, which covers individuals unemployed for one year or more and reflects more persistent or sticky

unemployment. In addition, the broad unemployment rate, which includes discouraged workers and involuntary part-time workers not included in the standard unemployment rate, and the EU flow (Employment to Unemployment flow), which captures the transition of the labor force from employment to unemployment,[22] are also utilized in analyzing conditions, as indicators including the margins of the unemployment pool.

Labor market indicators other than the unemployment rate include the *Tankan* employment conditions DI, which captures the perception of labor shortage from the firm side, the accession-separation rate gap, which looks at the discrepancy between labor inflow and outflow at establishments, and the Beveridge ratio, defined as the vacancy rate divided by the unemployment rate excluding self-employed and family workers. Furthermore, the labor input gap, a component of the output gap, and the employment rate gap, its breakdown, also exhibit fluctuations different from the overall output gap in certain phases. These indicators can be traced back to the bubble economy period of the 1980s when labor market tightness was clear, making it possible to review their relationship with wages and prices over the long term.

[22] In correcting for the bias inherent in the flow data of the *Labour Force Survey*, a methodology similar to Sakura (2006) is used.

Chart 21. Overview of Output Gap and Labor Market Indicators

Indicators			Overview	Source	Frequency
Overall Economy		Output Gap	Estimates labor and capital slack based on a Cobb-Douglas production function.	Bank of Japan	Quarterly
		Tankan Factor Utilization Index	Calculated as the weighted average of the employment conditions DI and the production capacity DI using labor and capital shares.	Bank of Japan	Quarterly
Labor Market	Total Labor Input	Labor Input Gap	Sum of labor force participation rate gap, employment rate gap, and hours worked gap.	Bank of Japan	Quarterly
	Labor Shortage Sentiment and Hiring Appetite of Firms	Beveridge Ratio	Calculated as vacancy rate / unemployment rate excluding self-employed and family workers. Vacancy rates are calculated based on the *Employment Referral Statistics* until 2019/Q4, and based on the *Survey on Labour Economy Trend* from 2020/Q1 onward.	Ministry of Health, Labour and Welfare, *Employment Referral Statistics* / *Survey on Labour Economy Trend*; Ministry of Internal Affairs and Communications, *Labour Force Survey: Basic Tabulation*	Quarterly
		Tankan Employment Conditions DI	Respondents choose from "Excessive," "Adequate," or "Insufficient" regarding employment conditions.	Bank of Japan	Quarterly
	Unemployment Pool	Broad Unemployment Rate	Considers discouraged workers and involuntary part-time workers in addition to the unemployed.	Ministry of Internal Affairs and Communications, *Labour Force Survey: Detailed Tabulation*	Quarterly
		Unemployment Rate	Persons who did not work at all during the survey week (the last 7 days of the month), were seeking work, and could start immediately.	Ministry of Internal Affairs and Communications, *Labour Force Survey: Basic Tabulation*	Monthly
		Short-term Unemployment Rate	Unemployed for less than one year.	Ministry of Internal Affairs and Communications, *Labour Force Survey: Detailed Tabulation*	Quarterly
		Long-term Unemployment Rate	Unemployed for one year or more.	Ministry of Internal Affairs and Communications, *Labour Force Survey: Detailed Tabulation*	Quarterly
		Employment Rate Gap	Estimated employment slack considering structural unemployment based on UV analysis.	Bank of Japan	Quarterly
	Transitions between Labor Pools	Accession-Separation Rate Gap	Difference between accession and separation rates at establishments.	Ministry of Health, Labour and Welfare, *Monthly Labour Survey*	Monthly
		EU Flow	Probability of a person employed in the previous month moving into the unemployed category in the current month.	Ministry of Internal Affairs and Communications, *Labour Force Survey: Basic Tabulation*	Monthly

3-2. Predictive Power for Wages and Prices

The following section examines, using Granger causality tests, whether each of the labor market indicators discussed in the previous section provides additional significant predictive power for nominal wages and consumer prices beyond that of the output gap.

First, testing whether the output gap has Granger causality for nominal wages and consumer prices using long-term data (1986–2025) confirms that it has significant predictive power for each with statistically significance (Chart 22). Next, after controlling for the output gap, whether adding each labor market indicator as an explanatory variable provides additional predictive power for nominal wages and prices is tested. As a result, we find that Granger causality exists for either wages or prices for the *Tankan* factor utilization index, the Beveridge ratio, the *Tankan* employment conditions DI, the unemployment rate, the employment rate gap, and the accession-separation rate gap; that is, these indicators have additional predictive power for wages or prices even after controlling for the effect of the output gap.

Chart 22. Key Supply-Demand Indicators for Wage and Inflation Forecasting

Granger Causality Test (P Value)	(1)Output gap →Hourly nominal wages	(2)Output gap →CPI less fresh food and energy
Output gap	0.000 ***	0.000 ***

Granger Causality Test (P Value)		Output gap is included as a control variable	
		(1)Each labor market indicator →Hourly nominal wages	(2)Each labor market indicator →CPI less fresh food and energy
Overall	*Tankan* Factor Utilization Index	0.028 **	0.014 **
Labor Market	Labor Input Gap	0.208	0.162
	Beveridge Ratio	0.001 ***	0.001 ***
	Tankan Employment Conditions DI	0.027 **	0.012 **
	Broad Unemployment Rate	0.182	0.061 *
	Unemployment Rate	0.010 ***	0.281
	Short-term Unemployment Rate	0.214	0.145
	Long-term Unemployment Rate	0.217	0.624
	Employment Rate Gap	0.002 ***	0.337
	Accession-Separation Rate Gap	0.039 **	0.021 **
	EU Flow	0.330	0.655

Notes: 1. The table shows the estimation results of granger causality test conducted on first differences of (1) hourly nominal wages (year-on-year), (2) CPI less fresh food and energy (excluding effects of the consumption tax hikes and policies concerning the provision of free education, etc., seasonally adjusted, annualized quarter-on-quarter change), and each of the supply-demand indicators (seasonally adjusted). The estimation period is from 1986/Q1 to 2025/Q3 (for the *Tankan* factor utilization index, the period is from 1991/Q1 to 2025/Q3).

2. ***, **, and * indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively. Shaded areas indicate indicators for which the null hypothesis of "no Granger causality" is rejected at the 5 percent significance level.

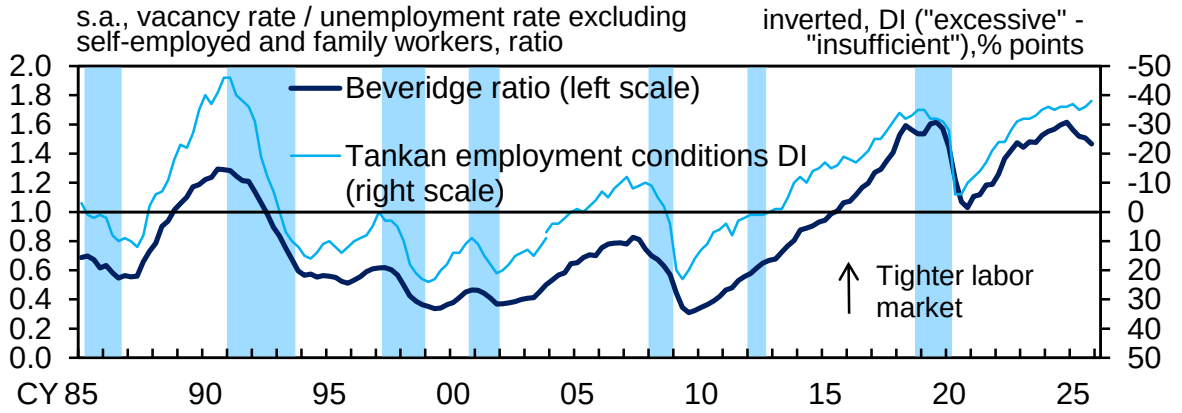
3. For hourly nominal wages, the data for 2020/Q2 and 2021/Q2 are interpolated using the average values of the preceding and following quarters to eliminate fluctuations associated with changes in working hours during the COVID-19 pandemic. Figures from 2016/Q1 onward are based on continuing observations following the sample revisions.

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

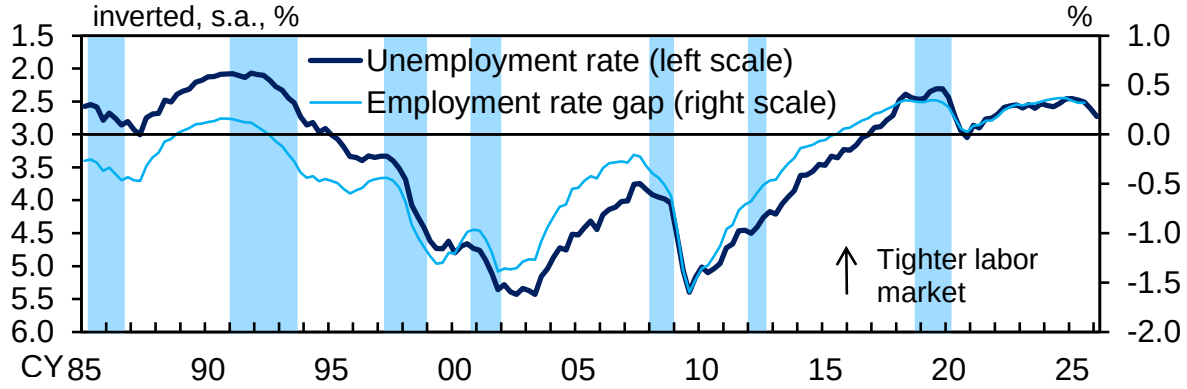
Looking at the developments of the labor market indicators which have additional predictive power for wages and prices (Chart 23), all indicators show that the degree of labor market tightness has been increasing recently. Some indicators, such as the Beveridge ratio and the employment rate gap, show that labor market conditions are tighter than the peak of the economic bubble period; based on these movements, it is possible that upward pressure on wages and prices from labor market conditions is more likely to be stronger than suggested by the output gap. Looking forward, it is considered desirable to utilize these labor market indicators as a complement to the output gap, which represents the macro supply-demand balance.

Chart 23. Developments in Labor Market Indicators

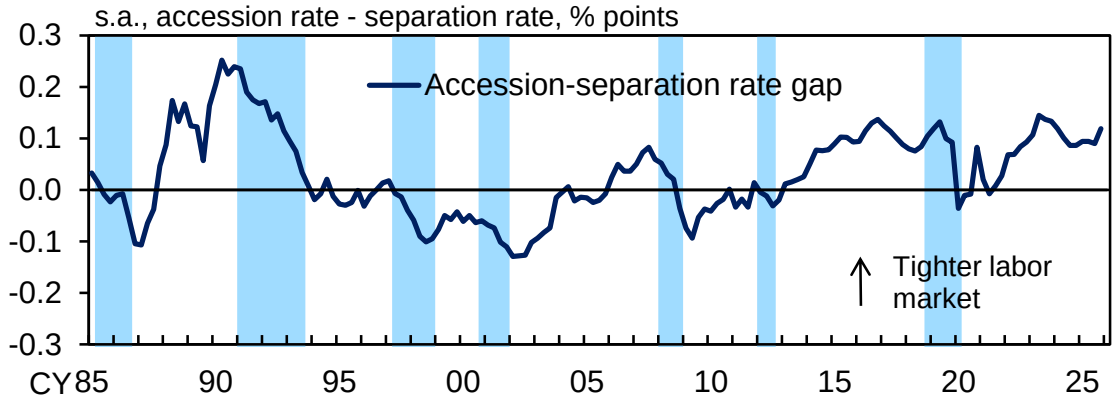
(1) Beveridge Ratio and *Tankan* Employment Conditions DI



(2) Unemployment Rate and Employment Rate Gap



(3) Accession-Separation Rate Gap



Notes: 1. Figures for the Beveridge ratio are calculated using vacancy rates calculated based on the *Employment Referral Statistics* until 2019/Q4, and using the *Survey on Labour Economy Trend* from 2020/Q1 onward. Figures from 2025/Q3 onward are estimates based on the DI for enterprises' employment conditions in the survey.
2. Accession-separation rate gap (through 1989 are for establishments with 30 or more employees) are 3-quarter central moving averages.
3. The figures for the unemployment rate and accession-separation rate gap for 2026/Q1 are those of January.
4. Shaded areas denote recession periods.

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

4. Conclusion

This paper detailed the updates of the output gap and potential growth rate, estimated and released by the Research and Statistics Department of the Bank of Japan, based on the benchmark year revision of 2020 in GDP statistics and recent changes in economic structure. In estimating and evaluating the macro supply-demand balance, it is necessary to always keep in mind issues such as model specification errors, the existence of estimation errors, and the difficulty of accurately capturing actual values in real time. For this reason, when utilizing these indicators for assessing economic conditions, it is important to evaluate them with a certain latitude and to continuously re-evaluate and update the methodologies based on structural changes and changes in available statistics, as was done in this revision.

Additionally, in light of the recent strengthening of labor supply constraints, a brief empirical analysis was conducted on whether labor market indicators provide additional predictive power for wages and prices even after controlling for the output gap. The results of this paper show that indicators such as (1) the *Tankan* factor utilization index, (2) the Beveridge ratio, (3) the *Tankan* employment conditions DI, (4) the unemployment rate, (5) the employment rate gap, and (6) the accession-separation rate gap have distinct characteristics compared to the output gap and help improve predictive power from the perspective of wage and price prediction. Based on these analytical results, the Research and Statistics Department of the Bank of Japan is releasing the aforementioned labor market indicators quarterly alongside the revised estimates of the output gap and potential growth rate as "Research Data" on the Bank's website.

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Annex 1: Piecewise Linear Regression with Multiple Breakpoints

This appendix explains the concept of the piecewise linear regression method used in estimating the labor force participation rate gap and the hours worked gap, and checks its robustness.

This revision of the output gap uses Muggeo (2003)'s methodology, which automatically detects kinks (unknown breakpoints) in the linear trend from data. This methodology has the advantage of being able to simultaneously estimate structural breakpoints while maintaining the continuity of variables, and is practically easy to implement in analytical software such as R or Stata. The specific method is as follows. Letting y_t be the dependent variable at time t, T_t be the time trend, and T_c be the kink point (breakpoint), the regression model is simplified as follows:

$$y_t = \beta_0 + \beta_1 T_t + \varepsilon_t \quad for \ T_t \leq T_c \qquad \text{A-1}$$

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 (T_t - T_c) + \varepsilon_t \quad for \ T_t > T_c \qquad \text{A-2}$$

Here, in Equation A-2 is the parameter showing the change in slope after the kink point. In other words, the linear regression model is applied by dividing the data into two segments before and after the kink point.

In searching for the kink point, after setting an arbitrary initial value, linear regression is performed for each segment, and the process is repeated by moving the kink point using the Newton-Raphson algorithm or other methods until the estimation error is minimized.[23] The above is a simplified example with one kink point, but this methodology is known to be effective even when estimating multiple kink points.[24]

However, because the kink points in this methodology depend on actual data, it carries the possibility that the assessment of past periods may change significantly ex-post as data accumulates. Therefore, it is important to check how the kink points detected through data accumulation change using recent data. Comparing the trends and gaps calculated at past points in time (Annex Chart 1), it can be confirmed that during periods when the trend changed rapidly, such as around 2014 or 2020, the kink points changed ex-post and the measured gaps were revised somewhat, whereas the magnitude of revision is not very large during periods when trend changes are relatively moderate.[25]

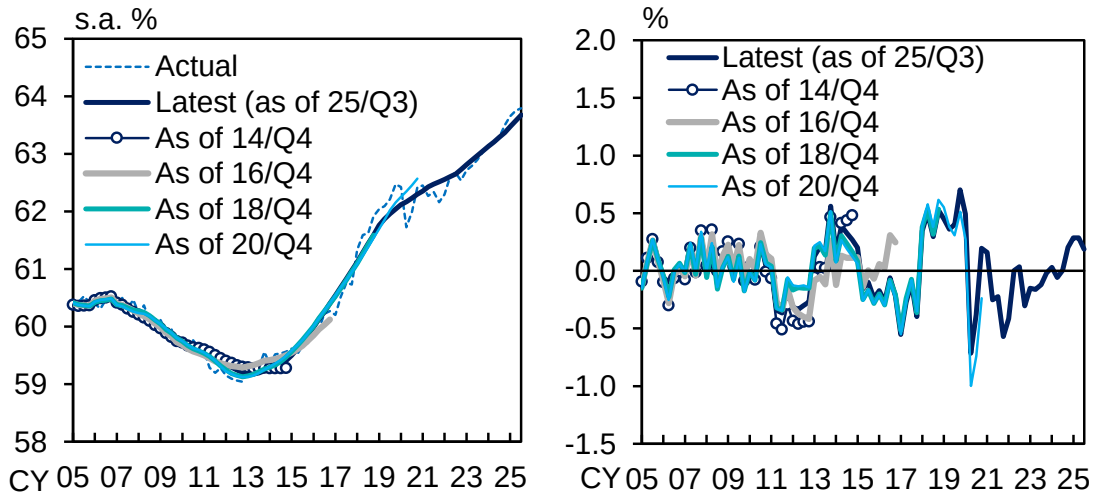
[23] Since the regression model here is linear, it has the advantage of having a smaller computational load compared to other methods that perform a grid search for structural breakpoints.

[24] The specification is made with the maximum number of structural breakpoints to be searched set at 10. Note that similar results are obtained even when the maximum number was increased.

[25] In order to reduce the magnitude of ex-post revisions, a practical method could be to provisionally allow a trend kink when institutional factors that could cause changes in the labor force participation

Annex Chart 1. Revisions of Labor Force Participation Gap

(1) Actual and Trend **(2) Gap**



Source: Ministry of Internal Affairs and Communications.

rate become clear.

Annex 2: Estimation Considering Structural Changes in the UV Curve Intercept

This appendix explains the estimation results for the UV curve, considering structural changes in the intercept.

In this revision, the long-term slope is estimated using the following specification, which allows the intercept of the UV curve to shift reflecting changes in matching efficiency and other factors:

$$\ln U_t = \alpha_k + \beta \ln V_t + \varepsilon_t \qquad \text{B-1}$$

Here, U_t and V_t represent the unemployment rate and the vacancy rate, respectively, and for the shift term of the UV curve (α_k), k structural breakpoints are detected using the Bai-Perron test.[26]

Annex Chart 2. Estimation Results of UV Curve

Logarithmic estimation	(1) Current UV Curve		（２）After the Revision	
Intercept (α)	1990/M1 - 1993/M12	1.4	1980/Q1 - 1989/Q1	1.6
			1989/Q2 - 1993/Q3	1.5
			1993/Q4 - 1998/Q2	1.7
			1998/Q3 - 2007/Q1	2.1
			2007/Q2 - 2016/Q2	2.0
			2016/Q3 - 2024/Q4	1.6
Slope (β)	-0.33		-0.39	
Adjusted R^2	0.69		0.91	
S.E. of regression	0.04		0.08	
Estimation period	1990/M1 - 1993/M12		1980/Q1 - 2024/Q4	
k			5	

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

Regarding the estimation results (Annex Chart 2), looking at the parameter (β) showing the slope of the UV curve, even in the revised model estimated as a period

[26] Even when the number of structural breakpoints is set higher than five, the estimated slope remains almost unchanged at around -0.40 to -0.41. When the number of structural breakpoints is set lower than five, the period from 1990 to 1993, which is often referenced in previous studies (e.g., JILPT, 2025), is included in the previous period and cannot be identified; therefore, k is set to 5 in this revision.

average incorporating structural breakpoints in the intercept, an obtained slope is comparable to the previous version (1990–1993).

Annex 3: Changes in the Environment Surrounding Hours Worked

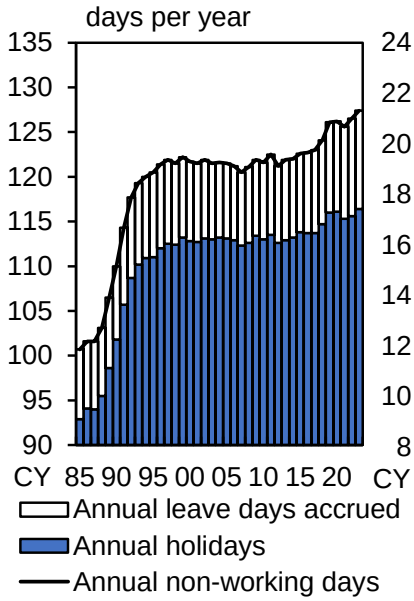
As previously confirmed, amongst hours worked, "days worked" in particular has seen clear kinks in the trend several times. This appendix conducts an examination of the structural factors behind these trend kinks.

Looking at days worked, the downward trend intensified in two periods: (1) 1988 to 1993, and (2) 2018 to 2021 (see Chart 8 in the main text). Regarding (1), the factor appears to be the widespread adoption of the five-day workweek in accordance with the reduction of statutory working hours from 48 hours per week to 40 hours per week in principle around 1990, which led to a significant decrease in days worked. In fact, looking at annual holidays among annual non-working days in Annex Chart 3-1(1), it can be confirmed that they increased sharply from around 95 days per year to around 110 days per year around 1990.

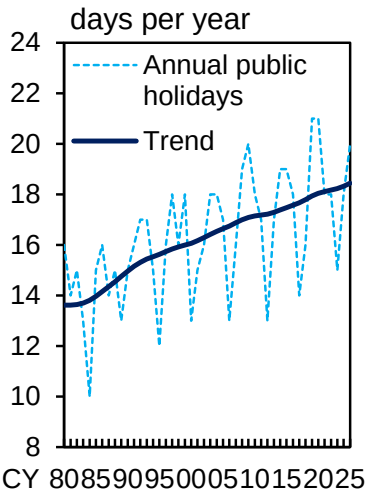
Regarding the period (2), it appears to have been influenced by the "Act on the Arrangement of Related Acts to Promote Work Style Reform" enforced in April 2019. Under this law, for workers who are granted 10 or more days of annual paid leave, employers are mandated to have them take five days by designating the timing, and as a result of this impact, non-working days are increasing again. In addition, in Japan, from a long-term perspective, (1) the number of annual public holidays is on an increasing trend (Annex Chart 3-1(2)), and (2) recently, the take-up rate of childcare leave by men is also on an upward trend (Appendix Chart 3-1(3)). These factors are also acting as downward pressure on the trend of days worked.

Annex Chart 3-1. Trends in the Number of Days Worked

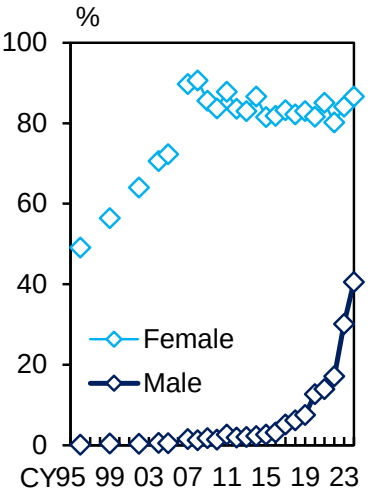
(1) Annual Non-Working Days



(2) Public Holidays



(3) Childcare Leave Acquisition Rate



Notes: 1. The annual holidays refer to the number of days determined as holidays by the company.
2. Annual public holidays exclude Saturdays and Sundays. Trends are calculated using the HP filter (λ=100).
3. The childcare leave acquisition rate is the percentage of males whose spouse have given birth and females that have started childcare leave.

Sources: Japan Institute for Labour Policy and Training; Ministry of Health, Labour and Welfare.

In this revision, in relation to (1) the number of annual public holidays, the data source for total hours worked was changed from the *Monthly Labour Survey* to the *Labour Force Survey* (Annex Chart 3-2). Comparing the developments in hours worked between the *Labour Force Survey* and the *Monthly Labour Survey* (Annex Chart 3-3), it is confirmed that not only is there a level gap, but the downward trend is clearer in the hours worked of the *Labour Force Survey* (potential hours worked decreased more).[27] Furthermore, by using hours worked from the *Labour Force Survey*, which is a survey of households, rather than the *Monthly Labour Survey*, which is a survey of establishments, it is expected that it will be possible to more flexibly capture changes in work arrangements, such as the expansion of side jobs and the spread of spot work and gig work.

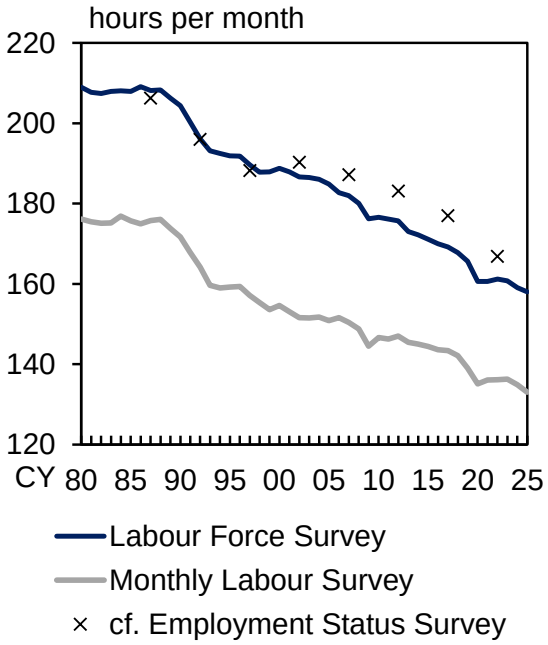
[27] For details on the difference in working hours between the *Monthly Labour Survey* and the *Labour Force Survey*, see Kambayashi (2010) and Yamamoto and Kuroda (2014).

Annex Chart 3-2. Comparison of Labor Hours Statistics

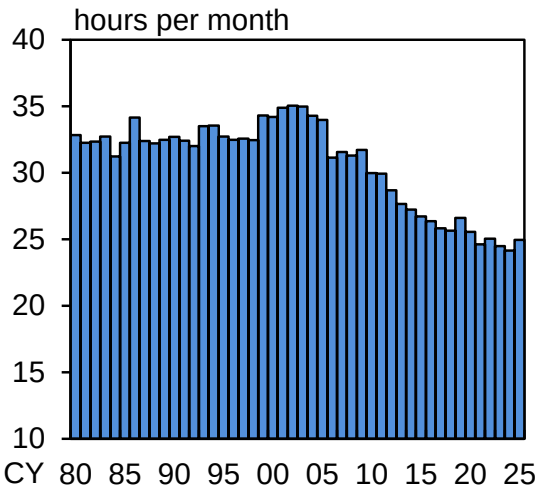
	Monthly Labour Survey	*Labour Force Survey*	*Employment Status Survey*
Frequency	Monthly	Monthly	Every 5 years
Coverage	Business survey (Approx. 30,000 establishments)	Household survey (Approx. 40,000 households)	Household survey (Approx. 540,000 households, October)
Measurements	Monthly hours worked	Hours worked in the last week of the month	Regular weekly hours worked
Features	・Covers businesses with 5 or more employees ・Covers regular employees only	・Including side jobs, home-based work, and temporary jobs ・Affected by the number of holidays in the last week of the month	・Data (except for 2022 survey) is number of individuals by hours worked classification. ・Excluding workers with fewer than 200 days of work per year and those with irregular employment.

Annex Chart 3-3. Comparing Labor Hours Statistics

(1) Developments in Monthly Working Hours



(2) Differences in Both Statistics <LFS - MLS>



Note: Working hours of *Labour Force Survey* are adjusted for the impacts of holidays in the last week of the month. Authors' estimates. Figures of *Employment Status Survey* are estimated based on the median of working hours categories and the number of respondents.
Sources: Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare.