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Potential Growth in Japan: Issues on Its Relationship with Prices and Wages

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Abstract

This paper looks back on the background of the sluggish potential growth and the slowdown in labor productivity growth since the 1990s in Japan, and raises some issues on their concepts and measurement, as well as on their relationship with prices and wages. Specifically, we point out that (1) there is a great deal of uncertainty in estimating the potential growth rate due to differences in approaches; (2) a decline in the potential growth rate could be accompanied by an even sharper decline in aggregate demand, leading to a worsening of the output gap; (3) the slowdown in labor productivity growth, combined with the decline in the labor share and the deterioration in the terms of trade, has exerted downward pressure on real wages; (4) the slowdown in labor productivity growth has also led to upward pressure on prices through rising unit labor costs; and (5) the prolonged deflation and low inflation themselves might have adversely affected productivity through suppressing demand for capital investment and other factors. While the sluggishness of potential growth and the slowdown in labor productivity growth are serious problems in themselves, monitoring these trends is also necessary for conducting monetary policy with the aim of maintaining price stability. It is also important to look at the relationship between productivity, prices, and wages from a variety of perspectives, while being mindful of the uncertainties in these estimates.

JEL classification numbers: E20, E30, J30, O47

Keywords: potential growth rate, labor productivity, prices, wages, Japan's economy

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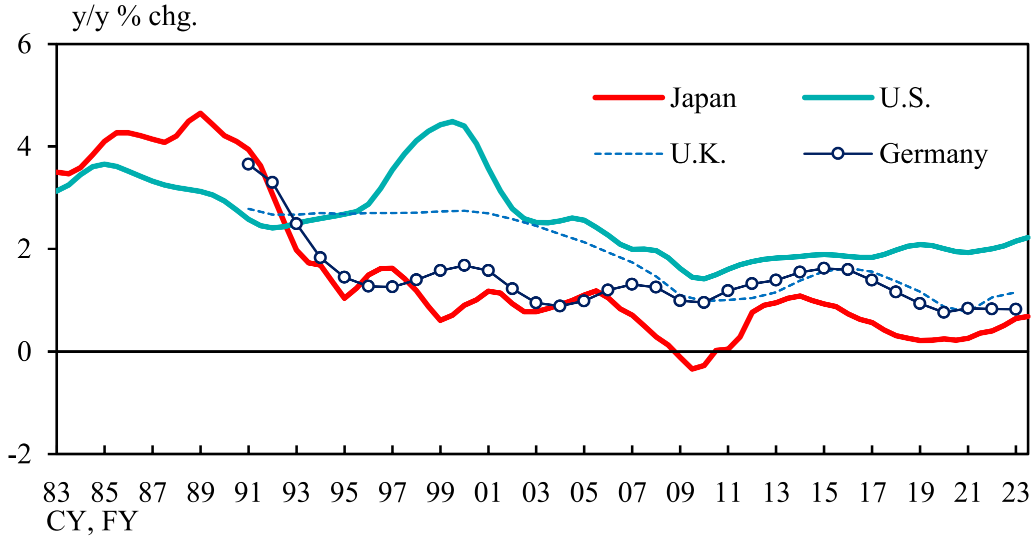
1. Introduction

Looking back at Japan's economy since the 1990s, in addition to the experience of deflation and low inflation, the decline in the trend of economic growth from the 1980s was also an important feature. In other words, not only did Japan's economy fall into deflation due to chronic demand shortages, it also experienced a weakening of potential supply capacity.[1] The "potential growth rate," which is the growth trend of supply capacity that smoothes out business cycles (fluctuations in aggregate demand), has been on a decreasing trend in many countries since the 1990s due to the slowdown in the pace of technological progress and capital accumulation, but Japan's potential growth rate has remained lower than that of other advanced economies (Figure 1).

(Figure 1) International comparison of the potential growth rates



Sources: Bank of Japan; FRED; OECD.

Note: Data for Japan are the BOJ staff estimates. Data for Japan and the U.S. are based on fiscal year (semi-annual), and those for the U.K. and Germany are based on calendar year (annual). The most recent data are for the second half of FY2023 (values for 2023/Q4) for Japan, the second half of FY2023 for the U.S., and CY2023 for the U.K. and Germany.

Various studies have been conducted in academia and at the Bank of Japan on the background to the lackluster growth of supply capacity and productivity of Japan's economy.[2] As part of the Bank's "Broad Perspective Review,"[3] this paper looks back on

[1] Various factors on the demand and supply sides of the economic stagnation and deflation in Japan since the 1990s are summarized in Fukunaga, Hogen, and Ueno [2024].

[2] Analyses by Bank of Japan staff include Nakamura, Kaihatsu, and Yagi [2019] and Yagi, Furukawa, and Nakajima [2022].

[3] Also in the European Central Bank's "Strategy Review," a research project on key factors behind productivity trends in EU countries was conducted (Modery *et al.* [2021]).

these studies and discussions, taking into account recent changes, and raises some issues on the concepts and measurement of the potential growth and productivity, as well as on their relationship with prices and wages. For example, by comparing the estimated potential growth rate with the actual economic growth rate, it is possible to grasp the direction of inflation pressure through changes in the "output gap," but there is also a great deal of uncertainty in the estimation of these variables depending on various approaches. In addition, if firms and households lower their growth expectations in response to a decline in the potential growth rate, their demand and the actual economic growth rate may fall below the potential growth rate, and the output gap may worsen, putting downward pressure on prices. Such a mechanism might be at work in Japan's deflation from the 1990s onwards. Moreover, the relationship between labor productivity (LP) and real wages, the relationship between unit labor costs and prices, and the question of whether deflation and low inflation themselves had any impact on productivity are also discussed in this paper. Our discussions throughout this paper show that constantly monitoring the trends in the potential growth and productivity is important for conducting monetary policy with the aim of maintaining price stability. We also emphasize that, in monitoring these trends, it is important to consider their relationship with prices and wages from a variety of perspectives, as well as the fact that the uncertainties in the estimation are inevitable.[4]

The remainder of the paper proceeds as follows. Section 2 discusses the estimation of the potential growth rate and some implications for its relationship with inflation. In Section 3, we consider factors that have influenced LP since the 1990s, which is closely related to the potential growth rate, and discuss its relationship with wages and prices. In Section 4, we discuss some issues related to the implications of inflation (or deflation) for productivity. Section 5 concludes.

2. Estimation of the potential growth rate and its implications

In this section, we first explain the "production function approach" to estimate the potential growth rate, which is a common method among various institutions including the Bank of Japan. We then briefly review the developments of Japan's potential growth rate estimated from this approach, and also compare it with estimates from alternative

[4] The natural rate of interest is a concept that is closely related to the potential growth rate, and the two are expected to coincide in the long run under certain assumptions. The natural rate of interest in Japan is estimated to be on a downward trend since the 1990s, but the estimates vary widely depending on the method used (Nakano, Sugioka and Yamamoto [2024]).

approaches that are considered in academia and other related fields. In addition, we discuss the relationship between the output gap - which is estimated in tandem with the potential growth rate - and inflation rates, as well as the relationship between the potential growth rate and medium- to long-term inflation expectations.

2-1. Estimating the potential growth rate from the "production function approach"

The production function approach at the Bank of Japan assumes that value added is determined by the inputs of labor and capital stock and the level of productivity. In this setting, "potential GDP" is defined as the average supply capacity of the economy which smooths out business cycles (fluctuations in aggregate demand). Specifically, we consider the following production function for the entire economy;

$$\log Y_t = \alpha \log L_t + (1-\alpha) \log K_t + \log A_t, \tag{1}$$

where Y_t, L_t, K_t denotes real GDP, labor input, and physical capital stock respectively (all terms in the equation are expressed in log levels[5]). α is a parameter which represents the long-run average of the labor share. A_t denotes the total factor productivity (TFP), that is, the efficiency of labor and capital inputs, and is assumed to be measured as the Solow residual, which resembles parts of GDP fluctuations which cannot be captured by fluctuations in factor inputs. Potential GDP (Y_t^*) is defined as the average production level or in other words, the level of real GDP in Equation (1) where labor and capital input is set at its long-run average (L_t^*、 K_t^*) and TFP is also set at its trend level (A_t^*). Then, the potential growth rate is defined as the growth rate of potential GDP and approximated as ($\log Y_t^* - \log Y_{t-1}^*$). The output gap (also called the GDP gap) is approximated as the log difference between actual GDP and potential GDP ($\log Y_t - \log Y_t^*$).

The above estimation method is widely used by the Cabinet Office of Japan, overseas central banks and government agencies (such as the U.S. Congressional Budget Office [CBO] and the European Commission), and international organizations (such as the IMF and the OECD). The Bank of Japan (Research and Statistics Department, the same applies hereafter) also estimates the potential growth rate using the production function approach, but the procedure for estimating the output gap differs from that of many other institutions, as explained in detail in Kawamoto *et al.* [2017]. That is, the output gap is estimated directly using the following equation, which is derived from the relationship between

[5] The original form of the production function in level is Cobb-Douglas; $Y_t = A_t L_t^{\alpha} K_t^{1-\alpha}$.

Equation (1) and potential GDP;

$$\log Y_t - \log Y_t^* = \alpha(\log L_t - \log L_t^*) + (1-\alpha)(\log K_t - \log K_t^*). \tag{2}$$

In this setup, the difference of TFP from its trend ($\log A_t - \log A_t^*$) is regarded as an observational error and not included in the definition of the output gap. The labor input gap ($\log L_t - \log L_t^*$), and the capital input gap ($\log K_t - \log K_t^*$) on the right-hand side (RHS) of Equation (2) are directly measurable from data on the utilization of factors of production (such as the labor participation rate, unemployment rate, hours per worker, capacity utilization, etc.), which enables to gauge the state of the output gap prior to the release of the official GDP statistics. Then, the potential growth rate is determined after the release of the official GDP statistics by recalibrating the TFP trend. By taking the above procedure, the output gap is calculated as a means to capture the degree of inflationary pressures in a timely manner.[6]

Next, we look back on the Bank of Japan's staff estimates of potential growth rate and output gap, as estimated above, since the 1980s. First, with regard to the potential growth rate (Figure 2), it hovered around 4 percent in the 1980s, but then fell rapidly to around 1 percent in the first half of the 1990s, and has since remained within the range of 0 to 1 percent (it temporarily fell into negative territory after the global financial crisis in 2008). The main factors behind the rapid decline in the early 1990s were the adjustment of the excess capital stock (decline in capital investment) caused by the collapse of the asset price bubble (the Heisei bubble), as well as the decrease in the statutory working hours (introduction of the five-day workweek) following the revision of the Labor Standards Act in 1988. The estimates show that decline in TFP growth, which was pointed out mainly in academia, did not contribute significantly to the decline of potential growth.[7] Since then, there has been little increase in newly built capital stock, and this has been the main cause of the sluggish potential growth rate. With regard to the amount of labor input (the number of workers times hours worked), while the number of hours worked

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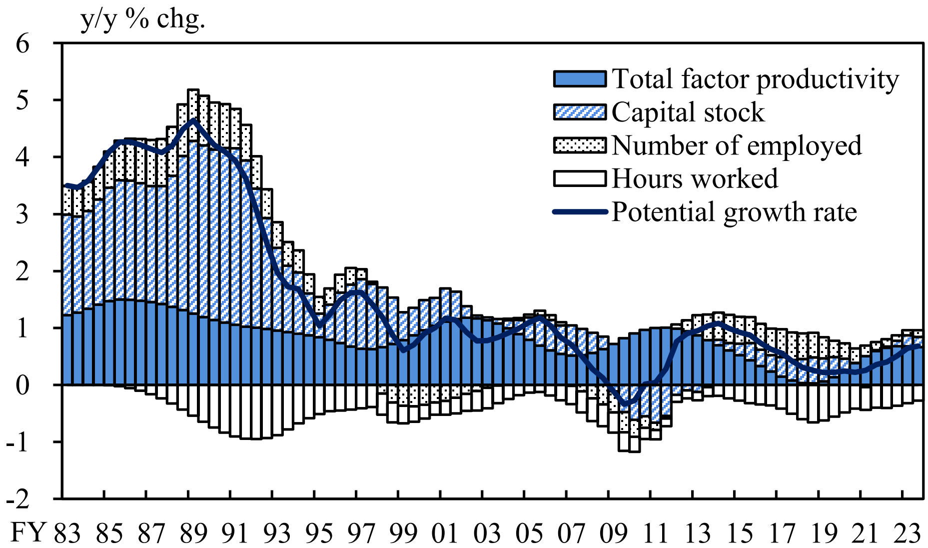
[6] The Bank of Japan's staff estimates of the output gap and the potential growth rate are released four times a year on the website below, and are also included in the background explanations of the *Outlook for Economic Activity and Prices* (Outlook Report).
https://www.boj.or.jp/en/research/research_data/gap/index.htm

[7] Hayashi and Prescott [2002] used a real business cycle model to show that Japan's lost decade of growth in the 1990s could be largely explained by the decline in the TFP growth and the decline in working hours. With regard to TFP, it has been pointed out that the decline in TFP growth may have been overestimated due to the fact that their model did not explicitly take into account factors such as changes in capacity utilization and labor hoarding. Triggered by this paper, many studies were conducted on the measurement of TFP (see Kawamoto [2005], Inui and Kwon [2005], etc.).

continued to decline due to the spread of the five-day workweek and the gradual increase in the ratio of part-time workers, the number of workers increased gradually (particularly in the 2010s) despite the declining working-age population. The fact that the potential growth rate has remained sluggish while the amount of labor input has not changed much suggests that LP has also not grown much either, as we discuss in Section 3.

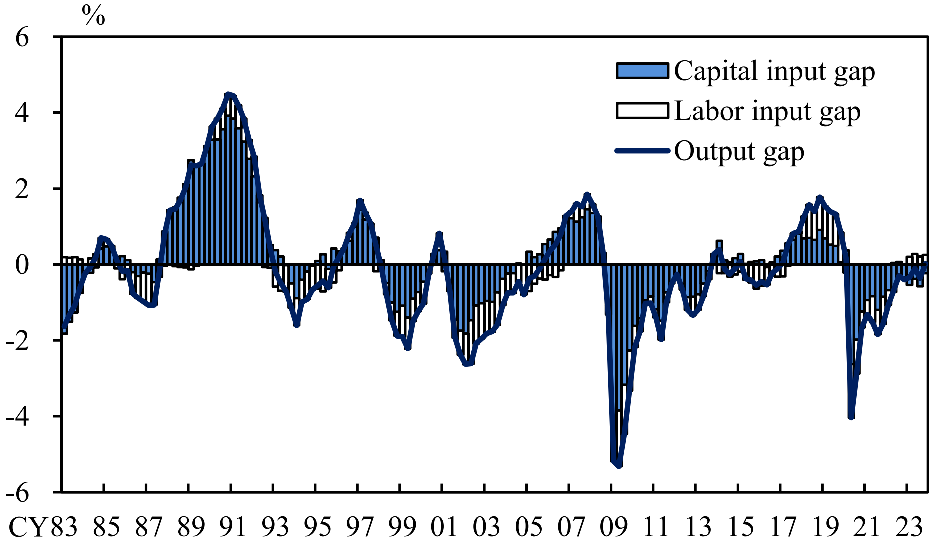
(Figure 2) Potential growth rate (BOJ staff estimates)



Source: Bank of Japan.
Note: The most recent data are for the second half of FY2023 (values for 2023/Q4).

Next, as for the output gap (Figure 3), after taking large positive values in the late 1980s during the bubble period, mainly due to the expansion of the capital input gap, it has recorded relatively small positive values and large negative values alternately. It is also worth noting that the duration of the periods when it was negative was longer. Both the capital input gap and labor input gap contributed to these fluctuations, but the contribution of the former was larger.

(Figure 3) Output gap (BOJ staff estimates)



Source: Bank of Japan.
Note: The most recent data are for 2023/Q4.

2-2. Alternative approaches for estimating the potential growth rate

The production function approach (PFA) described above is a method that has been established in practice for estimating potential growth rates and output gaps. However, since the PFA uses various data in addition to GDP statistics, such as labor statistics and capacity utilization rates, it is subject to several sources of measurement errors. In addition, there are also limits to the extent to which the PFA alone can capture changes in industrial structure and labor market structure in a timely manner, in order to identify a trend reflecting these structural changes while smoothing out business cycles. For these reasons, as discussed in Kawamoto *et al.* [2017], it is important to constantly review the estimation method based on the PFA. At the same time, however, it is also beneficial to check the robustness of the PFA-based estimates by comparing them with the estimates based on completely different approaches. In the following, we introduce two alternative approaches that have been considered mainly in academia, and compare the estimates based on these approaches with the PFA-based estimates.[8]

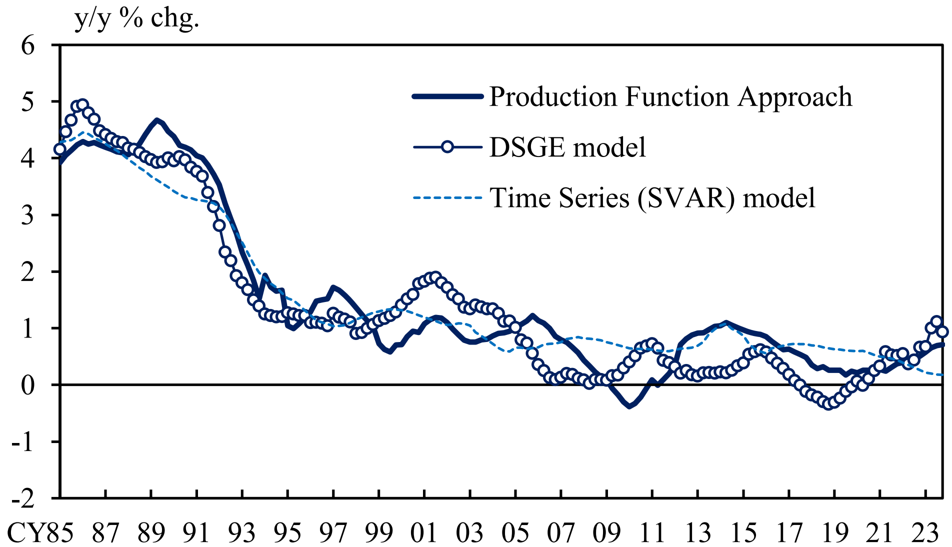
The first alternative approach uses a time series model (structural VAR), which identifies temporary and permanent shocks to real GDP (Blanchard and Quah

[8] In addition to the approaches introduced below, it is also useful to compare the output gap with the Diffusion Indices (DIs) for production capacity and employment conditions in the Tankan survey. Although there are differences in the levels of the weighted average of the two DIs and the PFA-based output gap estimated by the Bank of Japan, the direction and timing of fluctuations are similar.

decomposition), and considers the cumulative impact of the latter as potential GDP. This approach has the advantage that, when a large shock such as the global financial crisis in 2008 occurs, it is easier to identify the temporary and persistent effects in a short period of time compared to the PFA (Coibion, Gorodnichenko, and Ulate [2018]). The second alternative approach uses a dynamic stochastic general equilibrium (DSGE) model, which considers the hypothetical GDP (natural level of output) in the case where prices and nominal wages were flexible as the potential GDP. The advantage of this approach is that various factors affecting the estimated potential growth rate can be interpreted in line with the model structure.

Comparing the estimates of potential growth rate based on different approaches (for details of the estimation method, see Appendix 1) including the PFA (Figure 4), we can see that their trends are generally similar in that they declined rapidly from around 4 percent to around 1 percent in the early 1990s and then continued to stagnate, although there is a small difference of around 1 percentage point between these estimates.

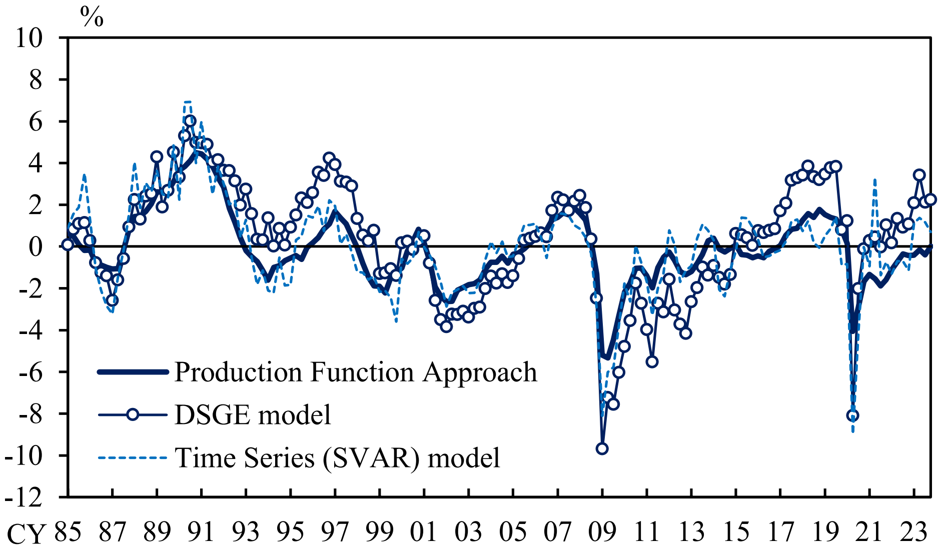
(Figure 4) Alternative estimates of the potential growth rate



Sources: Cabinet Office of Japan; Bank of Japan; Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry.
Note: The most recent data are for 2023/Q4.

Also, a comparison of the output gap estimates based on different approaches (Figure 5) shows that the direction and timing of fluctuations are generally similar, while there are some differences in the level and volatility. Based on these comparisons, the PFA-based potential growth rate and the output gap can be considered as robust, but should be viewed with some latitude.

(Figure 5) Alternative estimates of the output gap



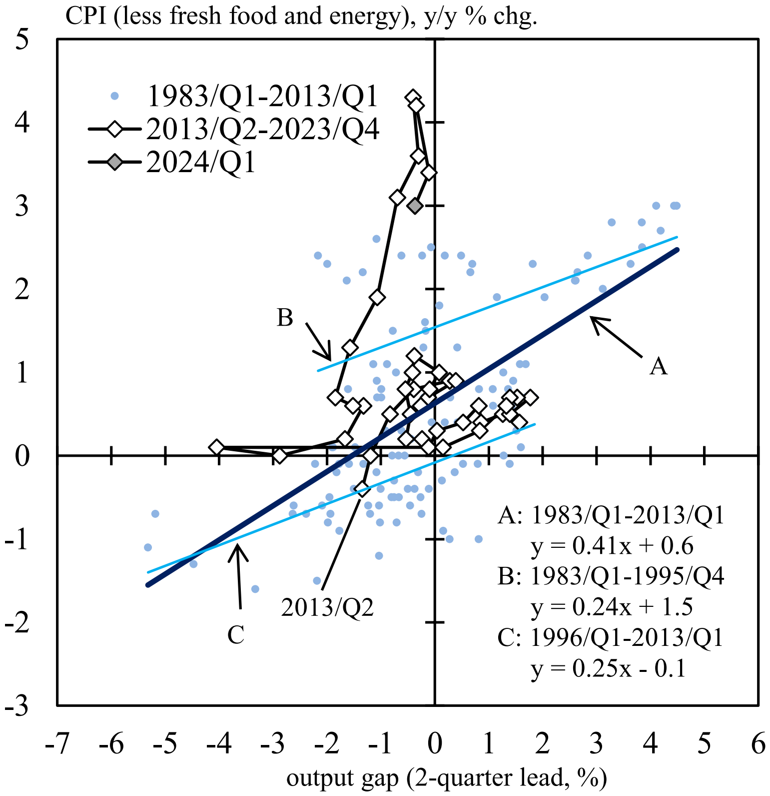
Sources: Cabinet Office of Japan; Bank of Japan; Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry.
Note: The most recent data are for 2023/Q4.

2-3. Relationship between potential growth, output gap, and inflation

One of the purposes of estimating the potential growth rate is to capture the inflationary pressure signaled from the output gap. The relationship between the output gap and inflation is often called the "Phillips curve," which is one of the core mechanisms in many macroeconomic models. In fact, we can see a moderate positive correlation between the output gap and consumer price inflation (CPI for all items less fresh food and energy, year-on-year rate of change, two quarter lead) over a long period from the 1980s (Figure 6), although the levels of both variables (their positions on the scatter diagram) have shifted in response to changes in the economic structure and inflation expectations.[9]

[9] A similar scatter plot is used in the Outlook Report of the Bank of Japan.

(Figure 6) Phillips curve



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

Note: The CPI data are the BOJ staff estimates and exclude mobile phone charges and the effects of the consumption tax hikes, policies concerning the provision of free education, and travel subsidy programs. Data for the output gap are the BOJ staff estimates.

This relationship can be confirmed by a more formal time-series analysis on the predictability of inflation. Compared to an auto-regressive (AR) model that predicts the inflation rate based solely on their own past values, models that add the output gap, estimated using the PFA and two alternative approaches explained above, as an explanatory variable have stronger predictability (i.e., smaller mean squared forecast error) of inflation (Figure 7). Furthermore, there is a growing body of research that has estimated a structural model of the Phillips curve based on the New Keynesian theory using Japanese data (e.g., Muto [2009] and Kurozumi and Oishi [2022]), showing that the output gap (which is a theoretical proxy for the real marginal cost) has some explanatory power for inflation.

(Figure 7) Predictability of inflation by output gaps

	MSFE (Mean Squared Forecast Error)		
	1Q ahead	4Q ahead	8Q ahead
CPI (All items)			
Production Function Approach	1.68	0.58	0.35
DSGE model	1.66	0.64	0.42
Time Series (SVAR) model	1.51	0.63	0.54
AR	1.84	0.84	0.75
CPI (All items less fresh food and energy)			
Production Function Approach	0.41	0.29	0.22
DSGE model	0.44	0.36	0.32
Time Series (SVAR) model	0.38	0.27	0.35
AR	0.47	0.45	0.52

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

Note: The lag structure of the explanatory variables is selected based on the SIC. The estimation period for the time series model is fixed to start in 1985/Q1, with the end period moving sequentially from 1999/Q1 to 2023/Q4. Forecast errors are measured for horizons of 1, 4, and 8 quarter ahead. For more details, see Section 5.2 of Fueki et al. [2016] and Coenen, Smets, and Vetlov [2009].

The Phillips curve relationship implies that, when the potential growth rate declines due to some factor on the supply side, inflationary pressure will increase through the tightening of the supply-demand balance. In fact, the recent surge of inflation has been explained, to a considerable extent, by supply constraints such as shortages of specific products, parts, materials, and labor. However, if these supply factors are temporary, they will not lead to persistent inflationary pressure (by definition, will not affect the potential growth rate[10]). In some cases, supply constraints can lead to a decline in demand and even deflationary pressure. For example, in the immediate aftermath of the Great East Japan Earthquake in 2011 and the pandemic in 2020, supply constraints in specific sectors led to a decline in demand in other related sectors, and the output gap worsened.[11]

[10] Potential growth is usually defined as a growth trend that excludes the effects of not only business cycles but also temporary supply factors such as a decline in capacity utilization due to supply constraints. However, if the production function differs from Equation (1) and the substitutability between production factors is low (similar to the Leontief type in the limit of zero substitutability), a shortage of a specific production factor (labor, equipment, raw materials, etc.) may become a persistent supply constraint, leading to a decline in the potential growth rate.

[11] Nakamura [2011] discusses various impact of the Great East Japan Earthquake on the demand and

Also in a case where the potential growth rate is declining due to persistent supply factors such as slowdown in technological progress and declining population, it is possible that growth expectations among firms and households will also decline, leading to decline in demand for capital investment, consumer spending on durable goods, and housing investment.[12] Conversely, further decline in capital investment due to demand factors such as the economic downturn could lead to decline in the potential growth rate through some hysteresis effects on the supply side.[13] As a result, if the actual economic growth rate falls even further than the potential growth rate, the output gap will worsen, leading to deflationary pressure. Furthermore, if the natural rate of interest (the level of interest rate that is neither accommodative nor restrictive) also declines in line with the potential growth rate, and an effective lower bound on nominal interest rates is binding, the effects of monetary easing will be less effective in countering deflationary pressure. In Japan, from the 1990s to the 2000s, the above mechanisms worked in combination, causing both the potential growth and inflation rates, as well as medium- to long-term growth expectations and inflation expectations, to decline in tandem (Figure 8).[14]

To sum up, when considering the implications of the potential growth rate and the output gap for inflation, it is important to take into account the persistence of demand and supply shocks, the interaction between them, and the response of monetary policy to them.

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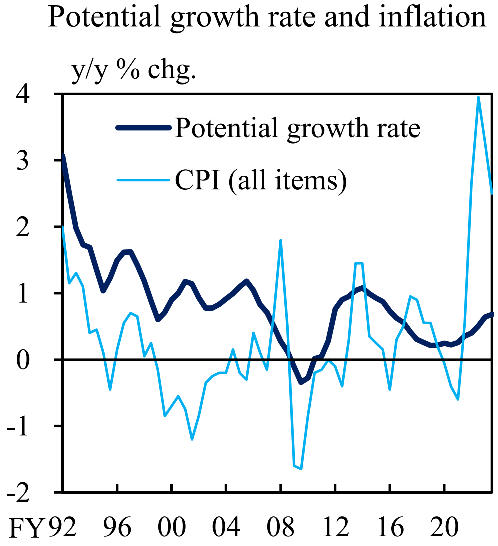
supply sides of Japan's economy, including the output gap and prices. On the mechanism by which a negative supply shock to specific sectors immediately after the COVID-19 pandemic led to a worsening of the output gap (Keynesian supply shock), see Guerrieri *et al.* [2022] among others.

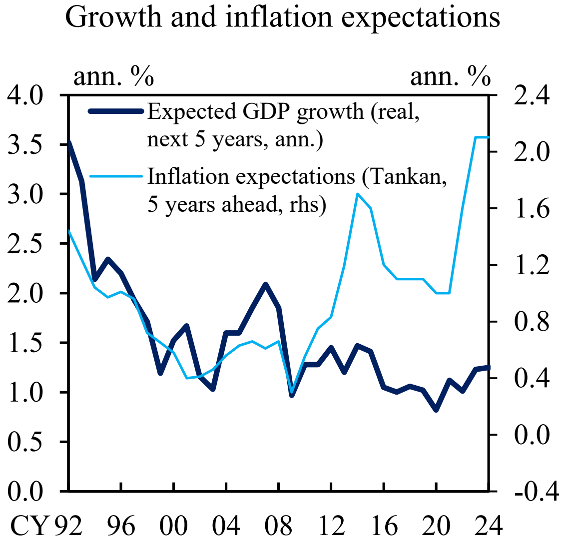
[12] In DSGE models that takes into account persistent shocks to the TFP growth, the inflation rate decelerates in response to a negative persistent shock to the TFP growth, similarly in response to a negative demand shock (Christiano, Trabandt, and Walentin [2010]). The DSGE model used in the estimation of Japan's potential growth rate using an alternative approach introduced in the previous subsection (Fueki *et al.* [2016]) also shows that the impulse response of the inflation rate to a technology growth rate shock goes in the same direction as the response to a demand shock.

[13] The possibility that demand factors have some spillover effects on the supply side through capital investment is discussed in Section 4. There are theoretical studies that point to the possibility that short-term business cycles can lead to medium-term cycles through factors such as research and development activities (Comin and Gertler [2006]).

[14] In other countries, there are few cases where the potential growth rate and medium- to long-term growth expectations moved in the same direction as inflation expectations.

(Figure 8) Potential growth rate, growth expectations, and inflation





Sources: Ministry of Internal Affairs and Communications; Bank of Japan; Cabinet Office of Japan; Nakajima [2023].

Note: The CPI (all items) in the left-hand chart is BOJ staff estimate and exclude mobile phone charges and the effects of the consumption tax hikes, policies concerning the provision of free education, and travel subsidy programs. The potential growth rate is also BOJ staff estimate. The expected GDP growth in the right-hand chart is the "Forecast of Japan's real economic growth rate: Next 5 years (all industries)" from the Annual Survey of Corporate Behavior. Data points are plotted according to the survey year. The values for inflation expectations before 2013 are estimates from Nakajima [2023]. The most recent data for the CPI (all items) and the potential growth rate are as of the second half of FY2023 and 2023/Q4, respectively. Those for the right-hand chart are as of CY2024.

3. Labor productivity, wages, and prices

In this section, we focus on labor productivity (LP), which is closely related to the potential growth rate. We look into the past trend of LP by industry and firm size, and also discuss LP's relationships with wages and prices. LP is defined as real value added (which corresponds to real GDP at the macro level) divided by total labor inputs (this can be either the number of workers or hours worked times the number of workers). Under the assumption of a production function in the form of Equation (1), LP can be written as,

$$\log Y_t - \log L_t = (1 - \alpha)(\log K_t - \log L_t) + \log A_t. \quad (3)$$

Definitions of the variables are the same as in Equation (1). LP (in log level) on the left-hand side (LHS) of Equation (3) can be divided into the capital-labor ratio (multiplied by capital share, $1 - \alpha$) and TFP.[15] Since the adjustment of $\log L_t$ tends to lag fluctuations in $\log Y_t$, LP is affected by business cycles (pro-cyclical) in the short-run. In this section, we focus on the medium-term trend of LP by taking moving averages, while in the previous section, we discussed potential GDP (Y_t^*) defined as the level of real GDP at the average utilization of capital and labor (L_t^*, K_t^*) and trend TFP (A_t^*).

In the literature, TFP is considered as a key indicator to measure the efficiency of production or the technology level by using both labor and capital.[16] TFP is also useful when comparing across industries, firm sizes, and countries with different industrial structures, as it is not affected by differences in the capital-labor ratio (while LP is affected by them). However, TFP has similar measurement issues as with the potential growth rate discussed in the previous section. We will focus on LP because it has relatively small measurement issues thanks to its simple definition and is widely used in practice.

3-1. Labor productivity at the macro level

There are two concepts of LP: per worker (the denominator is the number of workers) and per hour (the denominator is the number of workers multiplied by the number of hours worked). The former is more closely related to the labor income and economic welfare of workers, while the latter is more closely related to firms' efficiency and technological standards. The growth rates of LP per worker and per hour in Japan, as with the potential growth rate, fell significantly in the early 1990s, and then continued to

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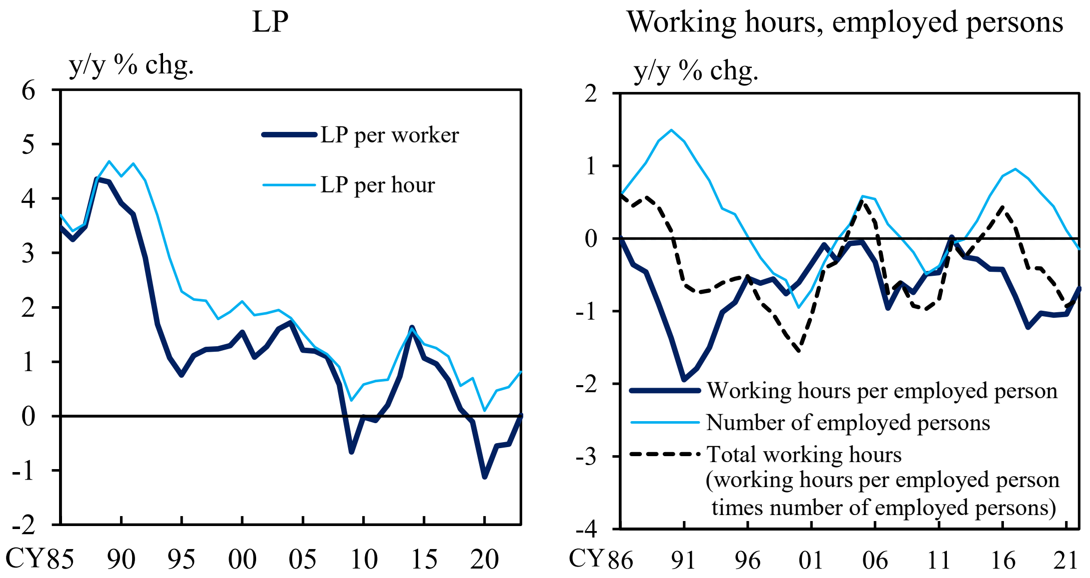
[15] In previous studies, the effects of education and changes in worker attributes, etc., are often considered as separate factors of LP, but in Equation (3), they are included in TFP.

[16] In the balanced growth path, which is theoretically considered as a long-run relationship, both LP and the potential growth rate are largely determined by the TFP growth.

stagnate at around 1 percent or less, while there have been some fluctuations (Figure 9, left chart). In particular, the growth in LP per worker has sunk into negative territory, and is even more sluggish than LP per hour. The difference between the two reflects the decrease in hours worked (Figure 9, right chart) due to the rising trend in the part-time workers ratio, the increasing participation of women and elderly people in the workforce, and the work style reforms.

(Figure 9) LP and working hours



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

Note: The LPs shown in the left chart are calculated as real GDP divided by either the number of employed persons (per worker) or the number of employed persons times hours worked (per hour). Both are calculated using a 5-year backward moving average. For the number of employed persons and hours worked in 2023, data from the Labor Force Survey and the Monthly Labor Statistics are used to extend the data. The most recent data in the left chart are for 2023 and the right chart for 2022.

The sluggish LP growth in Japan since the mid-1990s is in contrast to that in the U.S., where LP growth increased due to the use of information technology (IT) and other factors during the same period. Since then, Japan's LP growth has lagged behind that of the U.S. (Figure 10, top charts).[17] In European countries, LP growth has continued to stagnate, as in Japan, but their LP levels are well above that of Japan (Figure 10, bottom charts). In addition, the rapid LP growth in South Korea and China has brought them up to the levels close to that of Japan (South Korea's LP level per worker overtook Japan in the 2010s).

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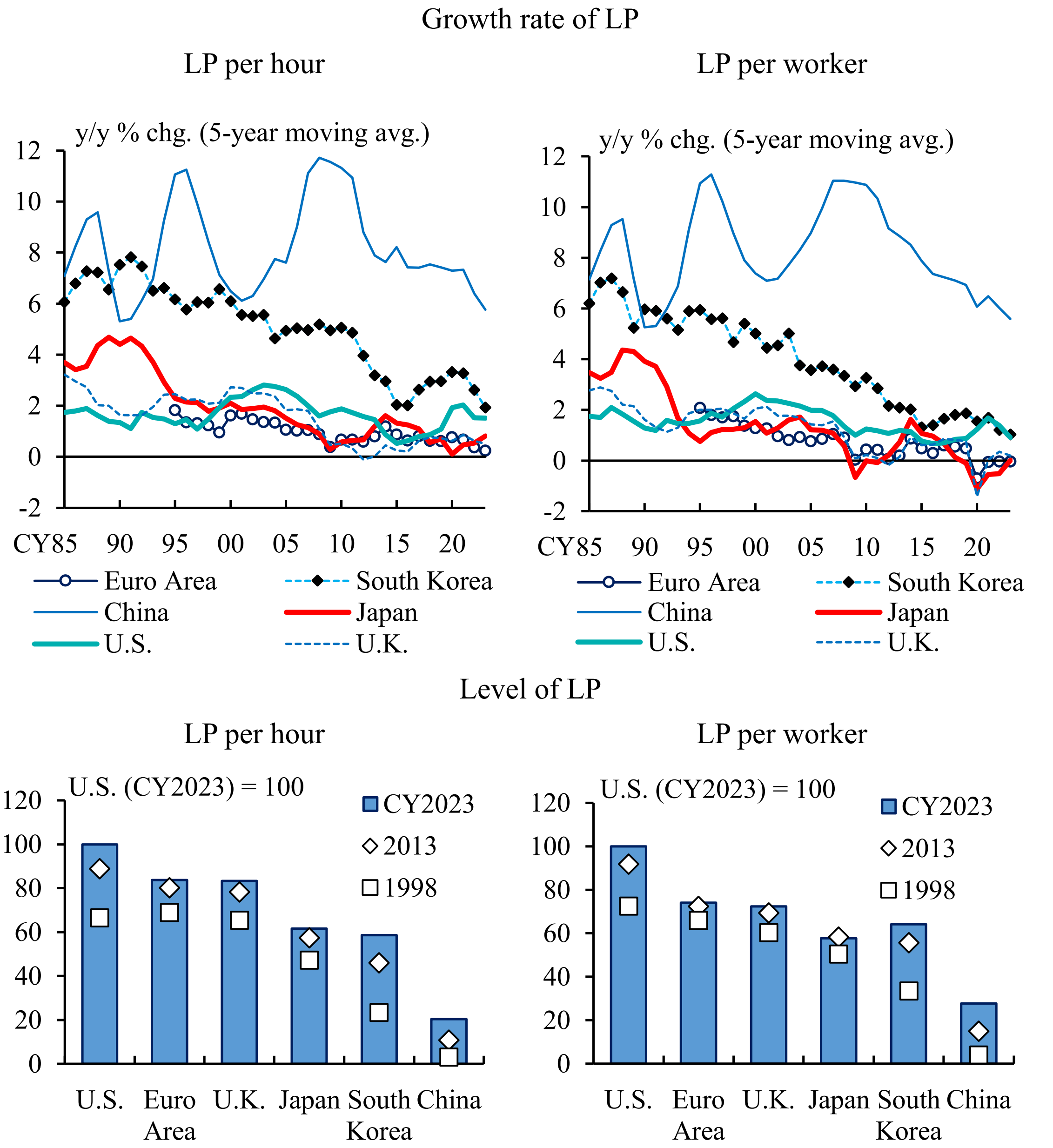
[17] Jorgenson, Nomura, and Samuels [2018] discuss in detail productivity (TFP) differentials between Japan and the U.S. Hogen and Kishi [2024] estimate a DSGE model of Japan and the U.S. and show that the productivity gap between the two countries explains the trend of real exchange rate.

(Figure 10) Cross-country comparison of LP



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

Note: Data for growth rates of LP are 5-year backward moving averages. The most recent data are as of 2023. Data for levels of LP are converted to U.S. dollars based on 2022 purchasing power parity.

The reasons behind the sluggish growth in Japan's LP include some common factors to other developed countries (particularly in Europe), as well as other factors that are unique to Japan. Some of these factors have influenced the TFP growth and others the growth in capital input (capital investment) as shown in Equation (3) above,[18] but actually, many

---

[18] Goldin *et al.* [2024] show that, while many developed countries saw a slowdown in LP growth from

factors have influenced both. Some key factors pointed out in the literature include (A) sluggish growth in domestic capital investment, (B) insufficient investment in IT and intangibles and their utilization, (C) changes in industrial structure and stagnant reallocation across firms, (D) labor market rigidities, (E) population aging, (F) globalization, (G) regulations, and (H) corporate governance (see Appendix 2 for details).

3-2. Labor productivity by industry and firm size

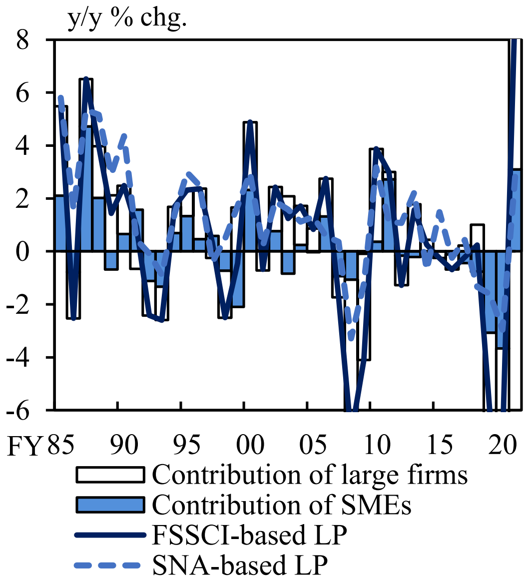
In this section, in order to decompose LP into contributions by industry and firm size, we calculate real value added using the Financial Statements Statistics of Corporations by Industry (FSSCI) instead of real GDP from the System of National Accounts (SNA).[19] Specifically, nominal value added (operating profits + personnel expenses + taxes and public dues + rental or leasing expenses for fixed and liquid assets + depreciation) from the FSSCI is converted to real terms using the JIP database's value added deflator. It can be confirmed that LP per worker (all industries, all firm sizes) based on the FSSCI, which divides this real value added by the number of employees, is generally consistent with changes in LP per worker based on SNA (Figure 11, left chart). By classifying the FSSCI-based LP into that of large firms with capital of 100 million yen or more and LP of small and medium-sized enterprises (SMEs) with less than that, we can see that SMEs have contributed to macroeconomic fluctuations in LP to a reasonable extent, as they have a large number of employees (about 70 percent of the total).

1995-2005 to 2006-2015, in Japan, unlike other developed countries, most of the slowdown was due to a growth slowdown in the capital-labor ratio, rather than TFP.

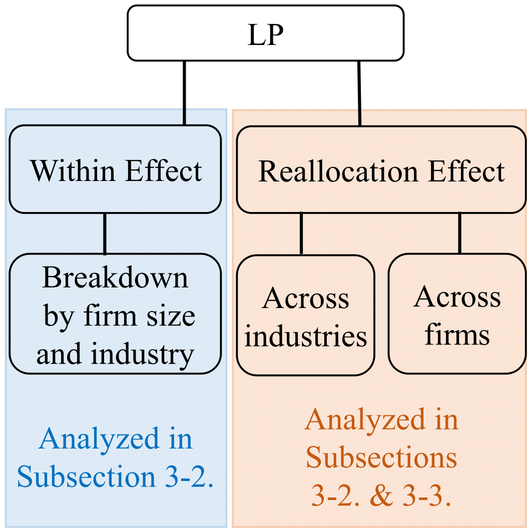
[19] As data on hours worked by firm size is limited, this subsection will focus on LP per worker.

(Figure 11) Decomposition of LP

Comparison of LP based on SNA and FSSCI



Focal point of decomposition of LP



Sources: Research Institute of Economy, Trade and Industry; Ministry of Finance; Cabinet Office of Japan.
Note: In the left chart, data for LP are on a per worker basis (see the main text for the details), and contributions are toward FSSCI-based LP. The most recent data are as of FY2021.

Next, in order to look at the relationship between macro and industry-specific LP, we decompose the growth rate of macro LP into the within and reallocation effects, as shown in the following equation.[20]

$$\frac{\Phi_t-\Phi_{t-1}}{\Phi_{t-1}} = \underbrace{\frac{\sum_i s_{i,t-1}(\phi_{i,t}-\phi_{i,t-1})}{\Phi_{t-1}}}_{\text{within effect}} + \underbrace{\frac{\sum_i (s_{i,t}-s_{i,t-1})(\phi_{i,t}-\tilde{\phi}_t)}{\Phi_{t-1}}}_{\text{reallocation effect}}. \tag{4}$$

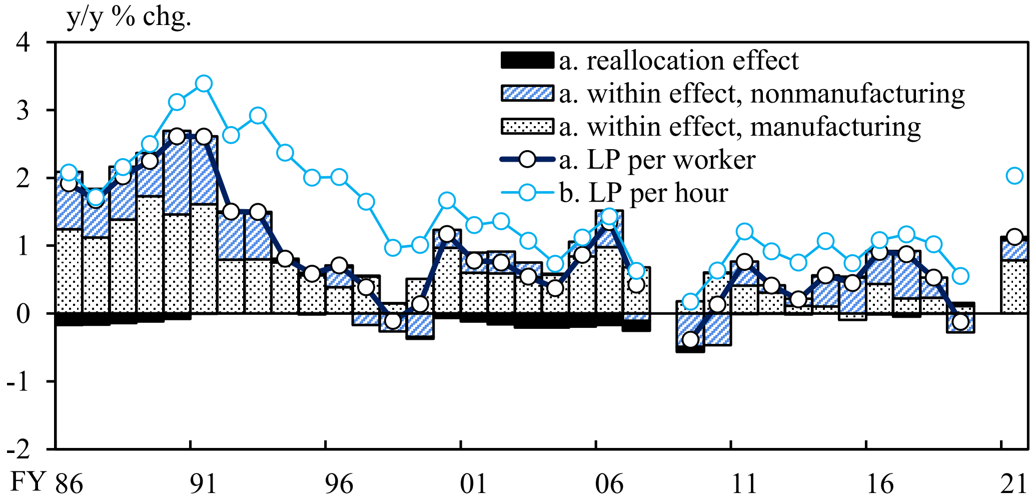
Here t denotes the time period, Φ_t is the level of macro LP, $s_{i,t}$ is the share of workers in industry i, $\phi_{i,t}$ is the level of LP in industry i, $\tilde{\phi}_t$ is the simple average level of LP across all industries. The first term of the RHS of Equation (4) represents the within effect, and the second term represents the reallocation effect across industries. The within effect is the contribution of changes in LP growth of each industry to the macro LP growth when the share of workers in the previous period is held constant. The reallocation effect is the contribution of changes in the share of workers on the macro LP

[20] In this analysis, we do not explicitly consider the possibility that changes in productivity (e.g. technological progress) may spill over across industries through intermediate goods and investment goods. According to Shirota and Tsuchida [2024], which takes such possibilities into account, the decline in the long-term economic growth trend up to the 1990s was largely due to factors common to all industries, and from the mid-2000s, factors specific to the machinery industry, including electrical machinery, which has a large spillover effect on other industries, also pushed down the growth trend.

growth. In the following, after an overview of the within effect and the reallocation effect across industries, we decompose the within effect by industry and firm size. The reallocation effect across firms will be discussed in Subsection 3-3 (Figure 11, right chart).

The results of the decomposition of Equation (4) shows that most of the macro LP growth can be explained by the within effects of each industry (Figure 12). The reallocation effect across industries had pushed down macro LP due to the increased share of workers in the non-manufacturing industry, which has relatively low LP, but the magnitude of this effect was limited.[21]

(Figure 12) Within effect and reallocation effect on macro LP growth



Sources: Research Institute of Economy, Trade and Industry; Ministry of Finance; Cabinet Office of Japan.
Note: Data are based on 7-year backward moving average, excluding FY2008 and FY2020, impacted by the global financial crisis (GFC) and the COVID-19 pandemic, respectively. LP per hour is derived from LP per worker calculated from FSSCI and from hours worked based on the SNA. The most recent data are for FY2021.

Next, we decompose the above within effect by industry and firm size (Figures 13 and 14). There are several features that are worth noting. First, in manufacturing, the growth rate of LP fell significantly in the 1990s, particularly for large firms (from 1.57 percent in the 1980s to 0.30 percent in the 1990s for all sizes), and then remained low until the 2010s at around the 0 percent growth. This was partly because domestic investment has

[21] The phenomenon of macro LP growth slowdown due to the increased share of value added in industries with low LP growth rates (non-manufacturing) is known as "Baumol's disease" or the "(negative) Baumol effect," and has been observed in many countries. On the other hand, the effect on macro LP of changes in the share of workers across industries with different levels of value added (inter-industry labor mobility) is called the "Denison effect" and can be either positive or negative. The "reallocation effect" in Equation (4) corresponds roughly to the sum of the Baumol effect and the Denison effect. (However, Equation (4) does not take into account the share of value added, and the above decomposition results may vary depending on the industrial classification.)

stagnated as the ratio of overseas production increased particularly among large firms, and the technology spillover from large firms to SMEs has weakened. Second, in the wholesale and retail industry, deregulation since the 1990s (Large-Scale Retail Stores Law, Large-Scale Retail Store Location Law) has led to the entry of large-scale stores with high productivity and the exit of small-scale and micro-enterprises. These made the slowdown in LP growth relatively small until the 2000s, but this effect faded in the 2010s. Third, in the construction industry, LP level had been continuously declining (LP growth had been negative), mainly in SMEs, due to delayed adjustment of employment in the face of the decreasing trend of public investment since the 1980s. After that, LP level started to increase slightly in the 2010s due to some progress in employment adjustment. Fourth, in services, the decreasing trend in LP level has continued since the 1990s to date.[22] In this background, changes in worker attributes, such as the use of non-regular employment with fewer hours worked per person, may have continued to affect this trend.[23]

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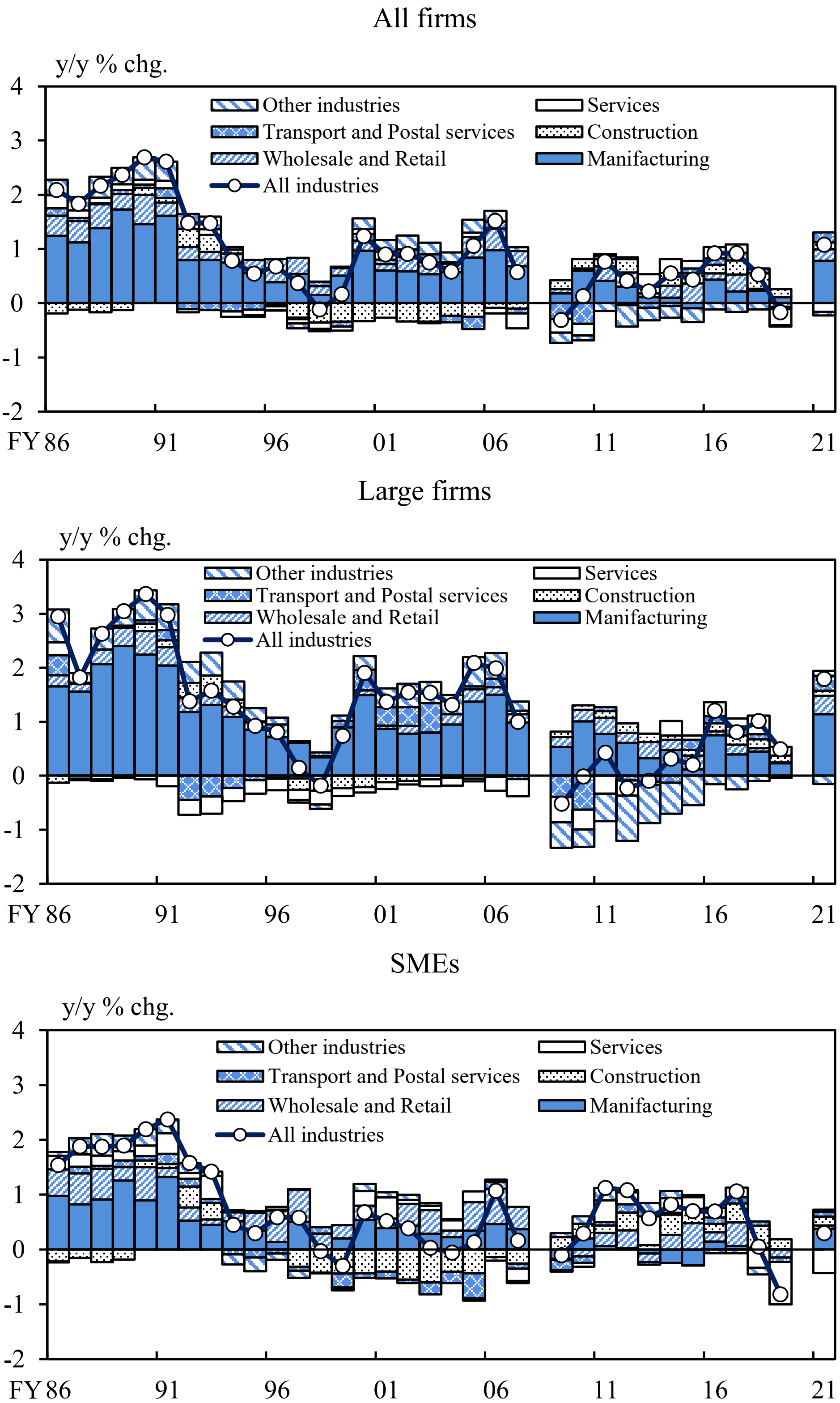
[22] LP growth in the service industry has continued to be negative since the 1990s for all sizes of firms, but has turned positive for SMEs in the 2000s and for large firms in the 2010s. In the 2000s, LP level of SMEs increased partly due to conversion to franchise stores in the food and beverage industry.

[23] As for other features by industry, in the "other industries," LP growth was negative to a large extent in the 2010s, particularly among large firms, reflecting the LP decline in the electricity industry after the Great East Japan Earthquake.

(Figure 13) Decomposition of LP growth by industry and firm size



Sources: Research Institute of Economy, Trade and Industry; Ministry of Finance.
Note: Data are based on LP per worker, calculated using a 7-year moving average, excluding FY2008 and FY2020, impacted by the GFC and the COVID-19 pandemic, respectively. The most recent data are for FY2021.

(Figure 14) Decomposition of LP growth by industry and firm size

All firms — contribution to y/y chg. in LP of all firms, %pts

	Within effect All industries	Manu-facturing	Non-Manu-facturing	Wholesale and Retail Trade	Construc-tion	Transport, Postal, and Comms	Services	Others	Reallo-cation Effect
1980s	2.66	1.57	1.08	0.28	-0.04	0.10	0.34	0.40	-0.11
1990s	0.21	0.30	-0.09	0.20	-0.09	-0.10	-0.14	0.04	-0.03
2000s	0.53	0.41	0.12	0.31	-0.03	-0.11	-0.09	0.04	-0.12
2010s	0.44	0.37	0.07	0.07	0.12	0.05	-0.05	-0.11	0.02

Large firms — contribution to y/y chg. in LP of large firms, %pts

	Within effect All industries	Manu-facturing	Non-Manu-facturing	Wholesale and Retail Trade	Construc-tion	Transport, Postal, and Comms	Services	Others
1980s	3.47	2.25	1.21	0.28	0.06	0.13	0.12	0.63
1990s	0.50	0.55	-0.06	0.04	-0.07	0.01	-0.21	0.18
2000s	0.46	0.67	-0.20	0.26	0.05	-0.07	-0.35	-0.09
2010s	0.89	0.63	0.26	0.06	0.10	0.06	0.20	-0.16

SMEs — contribution to y/y chg. in LP of SMEs, %pts

	Within effect All industries	Manu-facturing	Non-Manu-facturing	Wholesale and Retail Trade	Construc-tion	Transport, Postal, and Comms	Services	Others
1980s	2.11	1.10	1.01	0.28	-0.10	0.08	0.49	0.26
1990s	-0.01	0.11	-0.12	0.33	-0.10	-0.20	-0.08	-0.06
2000s	0.54	0.14	0.40	0.31	-0.09	-0.06	0.15	0.10
2010s	0.02	0.12	-0.10	0.08	0.13	0.06	-0.30	-0.07

Sources: Research Institute of Economy, Trade and Industry; Ministry of Finance.
Note: Data for LP are on a per worker basis. FY2008 is excluded due to the GFC.

3-3. Reallocation effect across firms

In the previous subsection, we showed that the reallocation effect across industries were limited using industry data, but by using firm-level data, it is possible to extract the reallocation effect across firms within the same industry (which was included in the within effect in the previous subsection).[24] According to Takizawa and Miyakawa [2022],[25] a recent example of such analysis, while the within effects of each firm have been the main factor in the macro LP growth, the contribution of the reallocation effect across firms has also been significant (Figure 15). For example, firms which increased labor inputs relative to other firms by using non-regular employment tended to experience decline in their LP levels, leading to decline in the macro LP level as well.[26] Meanwhile,

[24] Previous studies on the reallocation effect across firms in Japan include, Kim, Kwon and Fukao [2007], Ikeuchi *et al.* [2018], Fukao *et al.* [2021], Yagi, Furukawa, and Nakajima [2022].

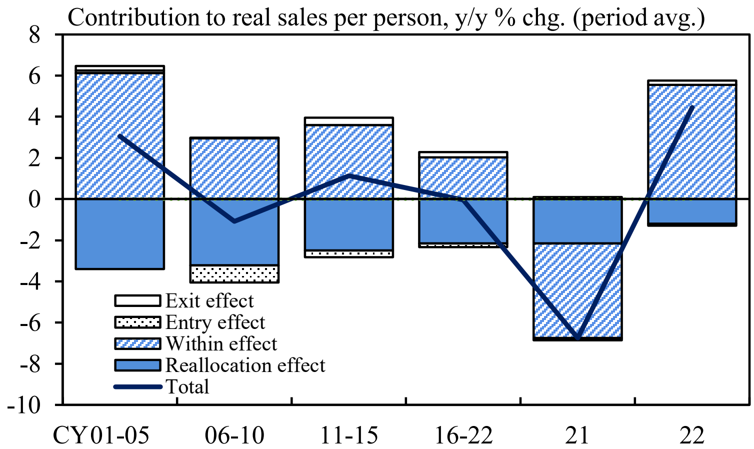
[25] Due to data constraints, real sales are used in the numerator of LP instead of real value added.

[26] The reallocation effect can be decomposed into the share effect and the covariance effect as follows

the impacts of the entry and exit of firms on macro LP were limited.

According to the above analysis, the negative contribution of the reallocation effect across firms has been gradually shrinking in recent years. In this relation, recent studies attempt to analyze the reallocation effect across firms in more detail using information on bankruptcies, business closures, and mergers. For example, it has been shown that the reallocation of resources from exiting firms to surviving firms in mergers has a positive impact on macro LP (Ito and Miyakawa [2022]). In recent years, the number of mergers has been on the rise partly due to the lack of successors to business owners, so it will be interesting to see whether this trend will boost macro LP through improved resource reallocation.

(Figure 15) Within and reallocation effects (firm-level))



Source: Takizawa and Miyakawa [2022].

(notations are the same as in Equation (4)).

$$\frac{\sum_i (s_{i,t}-s_{i,t-1})(\phi_{i,t}-\tilde{\Phi}_t)}{\Phi_{t-1}} = \frac{\sum_i (s_{i,t}-s_{i,t-1})(\phi_{i,t-1}-\tilde{\Phi}_{t-1})}{\Phi_{t-1}} + \frac{\sum_i (s_{i,t}-s_{i,t-1})(\phi_{i,t}-\phi_{i,t-1})}{\Phi_{t-1}}$$

The share effect (first term on the RHS) captures the impact on macro LP of changes in the employment share when the LP of firm *i* is fixed from the previous period. For example, if a firm with a relatively high level of LP expands its employment, the share effect will be positive. The covariance effect (second term on the RHS) is the cross-term of the change in the employment share and the change in LP, and is positive (negative) when both change in the same (opposite) direction. In the analysis of Takizawa and Miyakawa [2022], the share effect is positive, but the covariance effect is negative, and the sum of the two (reallocation effect) is negative (because the covariance effect is larger), suggesting that when employment shifts from low-LP firms to high-LP firms, LP increases (decreases) in the firms that lose (gain) employment, and the latter effect has a stronger impact on macro LP. In general, firms that reduce labor input are more likely to increase LP by increasing the capital-labor ratio and reducing excessive labor, so the fact that the covariance effect is negative itself is natural.

3-4. Labor productivity and real wage

In this subsection, we consider the relationship between LP and real wages. In theory, profit maximization induces firms to hire labor so that the marginal LP equals the real wage. In data, LP and real wages are supposed to co-move in the long-run, unless there are major changes in the labor share or the terms of trade. The latter point can be confirmed using the following equation,

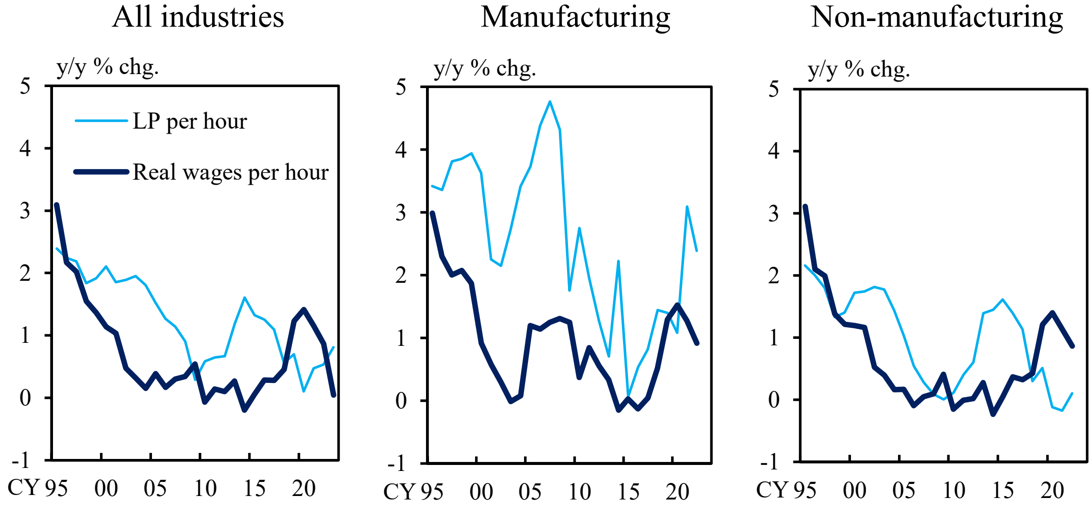
$$\frac{W_t}{P_t^C} = \frac{Y_t}{L_t} \times \frac{W_t L_t}{P_t Y_t} \times \frac{P_t}{P_t^C}. \tag{5}$$

The LHS is the real wage, where W_t and P_t^C denote nominal wage and household consumption deflator, respectively. The first factor on the RHS denotes LP, where as in Equation (3), Y_t denotes real GDP and L_t denotes the amount of labor input. The second factor on the RHS is the labor share, where P_t denotes the GDP deflator. The third factor is the relative price of the value added generated domestically (including exports) to household consumption (including imports), which corresponds to the terms of trade. On the assumption that the labor share and the terms of trade remain stable (or change following a constant trend), the trends of real wage and LP should generally co-move in the long run.

Growth rates of real wages and LP per hour in actual data (Figure 16) show that real wages have been suppressed compared to LP in both the manufacturing and non-manufacturing industries (particularly in the manufacturing industry up to the 2000s).[27] That said, their long-term trends from the mid-1990s appear to have co-moved.

[27] The real wages based on the compensation of employees in the SNA used in Figure 16 have been increasing since the second half of the 2010s, and this trend is somewhat different from that of real wages based on the Monthly Labor Survey (which stayed at around zero percent growth rate in the second half of the 2010s). This difference is due to the fact that the definition of wages is broader for the compensation of employees (which includes compensation of executives and social contributions by employers).

(Figure 16) Real wages per hour and LP



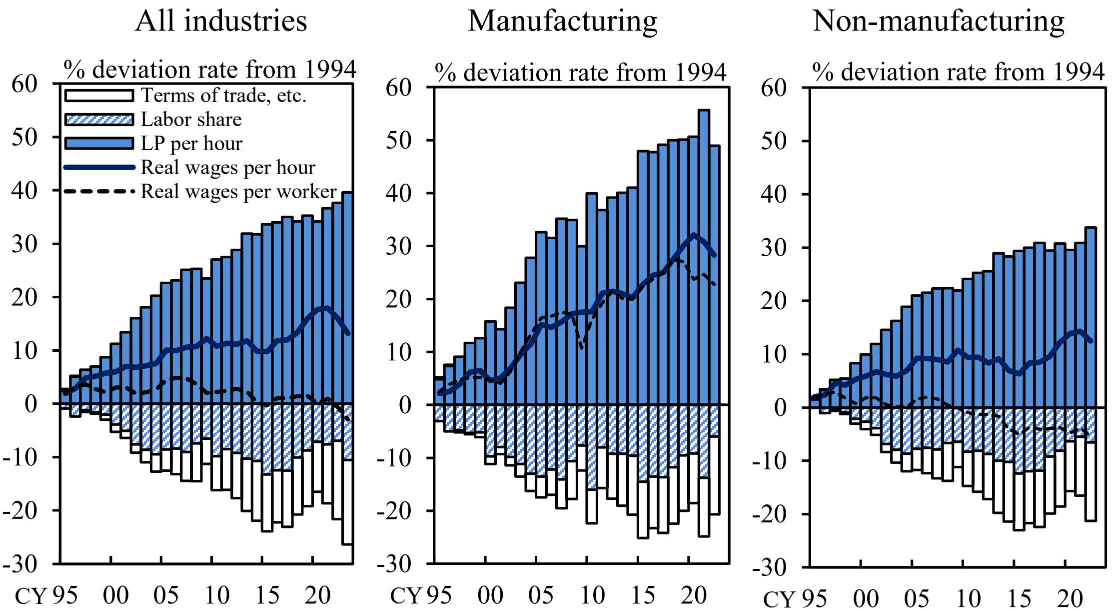
Sources: Ministry of Health, Labour and Welfare; Ministry of Internal Affairs and Communications; Cabinet Office of Japan.

Note: The most recent data for all industries are as of CY2023, while those for manufacturing and non-manufacturing are as of CY2022 (the same applies hereafter in this subsection). Data are 5-year backward moving averages. Data for real wages per hour are calculated as Real Compensation of Employees / (Number of Employees * Hours Worked).

Next, using the relationship in Equation (5), we decompose the level of real wages per hour (cumulative changes since the mid-1990s) into the contributions of LP, the labor share, and the terms of trade (Figure 17). The result shows that the level of real wages has been suppressed relative to LP due to both the decline in the labor share and the deterioration of the terms of trade. In non-manufacturing industries, LP growth has been slower than in manufacturing. This slower growth, combined with the labor share and the terms of trade pushing down real wages to the same extent as in manufacturing, has resulted in stagnant real wages per hour since the 2000s and widening the wage gap with manufacturing. Furthermore, in non-manufacturing industries, the level of real wages per worker, which is also shown in Figure 17,[28] has fallen below the mid-1990s level as working hours have decreased, driven by the increase in the part-time workers ratio (while in manufacturing, hours worked per worker has not decreased much, so the levels of real wages per hour and per worker are not much different).

[28] It is also possible to decompose real wages per worker into the contributions of LP per worker, labor share, and the terms of trade. The contributions of the labor share and the terms of trade are the same as those to real wages per hour shown in Figure 17.

(Figure 17) Decomposition of real wages per hour



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

Notes: 1. The household final consumption expenditure deflator excludes imputed rent of owner-occupied housing and FISIM.

2. For both manufacturing and non-manufacturing, it is assumed that the terms of trade faced by consumers are the same, and thus they are treated as identical to all industries. Additionally, the relative price factor, is considered to reflect the productivity of each industry, and is included in the LP.

As we have seen above, the slowdown in LP growth has led to a slowdown in growth in real wages, but in addition to this, the decline in the labor share and the deterioration in the terms of trade have also cumulatively put downward pressure on real wages.[29] The deterioration in the terms of trade is partly related to the sluggish LP growth in Japan compared to other countries.[30] On the other hand, the decline in the labor share may reflect the weakening of workers' wage-negotiation power and the expansion of wage markdowns (the wedge between nominal wage and the marginal revenue product of labor).[31]

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[29] The level of real wages by firm size can also be decomposed as in Figure 17. The cumulative downward pressure due to the decline in the labor share is greater for large firms and smaller for SMEs.

[30] Japan's terms of trade have been strongly affected by fluctuations in commodity prices such as the price of crude oil in the short term, but in the long term their impact has not necessarily been significant. For the relationship between the terms of trade and the productivity gap with other countries, see Hogen *et al.* [2024].

[31] For the estimates and implications of wage markdowns in Japan, see Aoki *et al.* [2023, 2024].

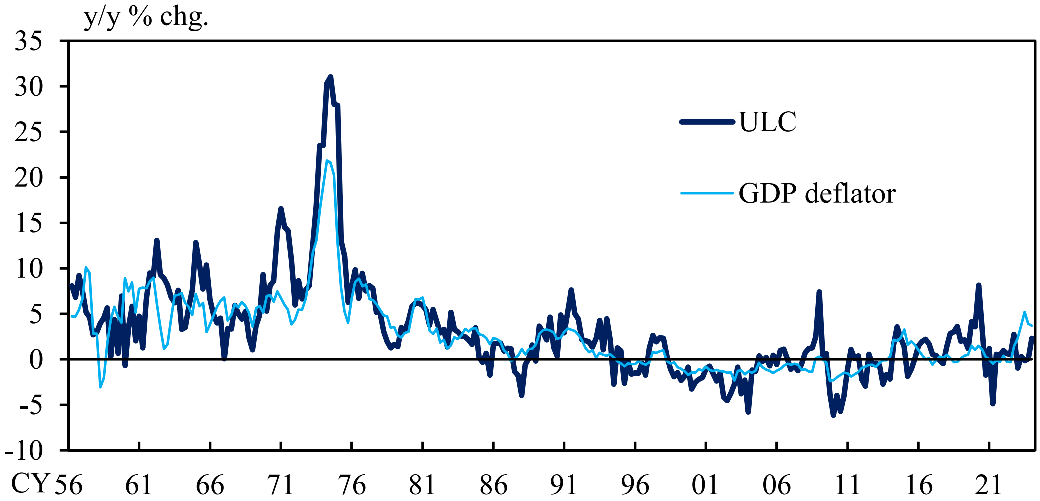
3-5. Unit labor costs

Lastly in this section, we look into the implications of LP for prices through the concept of unit labor costs (ULC). ULC is the labor cost per unit of output (or value added), and can also be defined as nominal wages divided by LP. Specifically, it is expressed as shown on the LHS of the following equation.

$$\frac{W_t L_t}{Y_t} = P_t \times \frac{W_t L_t}{P_t Y_t}. \tag{6}$$

Definitions of the variables are the same as in Equation (5) in the previous subsection. On the RHS, the first factor is the GDP deflator and the second factor is the labor share. As we discussed in the previous subsection, on the assumption that the labor share remains stable (or changes following a constant trend), the trends of ULC and the GDP deflator should generally co-move in the long run. In fact, the long-term trends of the two appear to have co-moved (Figure 18).

(Figure 18) ULC and GDP deflator



Source: Cabinet Office of Japan.
Note: The most recent data are as of 2024/Q1.

The relationship between ULC and GDP deflator does not necessarily correspond to the relationship between nominal wages and consumer prices, to the latter of which has been paid more attention in practice.[32] However, ULC is a key variable when assessing

[32] For the linkage between nominal wages and consumer prices (particularly service prices), see Ozaki

domestic inflationary pressure (homemade inflation) from the perspective of distribution of national income. It is also important to note that rising LP increases real wages (as discussed in the previous subsection), but decreases ULC, putting downward pressure on prices. For example, if a rise in nominal wages is accompanied by a rise in LP, ULC will not rise as much as nominal wages, therefore the increase in nominal wages may not be fully passed on to prices (part of the upward pressure on prices may be absorbed by the rise in LP).

With this relationship in mind, the decomposition of the ULC growth into growth in nominal wages in the numerator and LP growth in the denominator reveals the characteristics of the following three phases of Japan's economy from the mid-1980 (Figure 19). (1) From the mid-1980s to the mid-1990s, nominal wages grew at a faster rate than LP, so ULC growth was positive (inflationary pressure). (2) From the 2000s to the mid-2010s, nominal wages began to fall, and LP growth continued to be positive albeit at a slower pace than before, so ULC growth was negative from both factors (deflationary pressure). (3) From the mid-2010s onwards, while LP growth slowing further, nominal wages once again starting to rise, so ULC growth also turned positive. As we have seen, the direction of ULC movements in each phase has generally followed the direction of nominal wages, but the continued slowdown in LP growth throughout the three phases has made it easier for ULC to trend upwards (increasing pressure on prices). Indeed, the ULC growth in recent years has been similar to that seen in the early 1990s, when nominal wages were growing more strongly than in recent years (while in the manufacturing industry, ULC has continued to fall due to the recent increase in LP growth).

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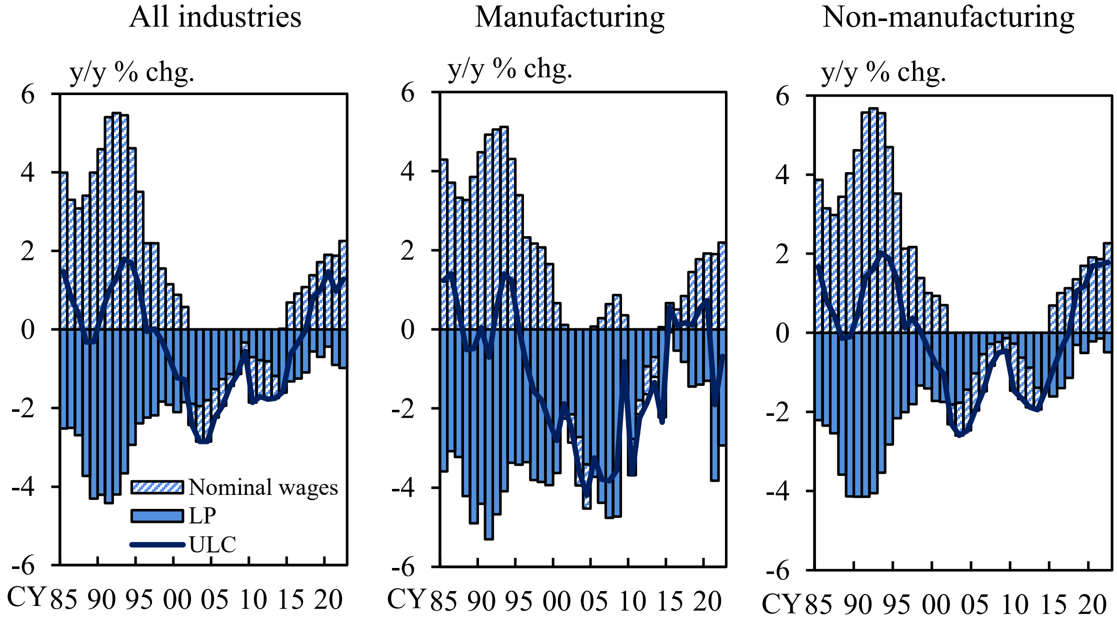
et al. [2024] and Ueno [2024].

(Figure 19) ULC decomposition



Source: Cabinet Office of Japan.
Note: Data for ULC are 5-year backward moving averages. Data for 2008 and 2020 are excluded due to the global financial crisis (GFC) and the COVID-19 pandemic. The most recent data are as of 2022.

4. Implications of inflation for productivity

So far in this paper, we have discussed the implications of potential growth (or output gap) and LP for prices, but did not touch on the other causal direction from prices to productivity. Traditionally in economics, nominal variables are assumed to have no effect on the trend of real economic activity in the long run. However, at least in the short run, there could be channels through which prices affect productivity, and there is also debate about the possibility that such effects may persist as a "hysteresis effect." In this section, we discuss several topics related to whether or not deflation and low inflation in Japan since the 1990s had any impact on productivity. These topics are also related to more general issues on the effects and side effects of monetary easing on productivity, and the optimal inflation for raising productivity, but these issues are beyond the scope of this paper.[33]

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[33] For the implications of the low interest rate environment in Japan for firms' productivity, including the effects and side effects of monetary easing, see Makabe and Yagi [2024]. For the medium- to long-term effects of monetary policy on the supply side, including productivity and the potential growth rate, see Haba *et al.* [2024], and for the implications of moderate inflation on the economy (including the desirable rate of inflation), see Bank of Japan [2024b].

4-1. Inflation (or deflation) and capital investment

First, we focus on capital investment as a channel through which prices can affect productivity (particularly LP). In the early 1990s, many firms in Japan were burdened with excessive debt following the collapse of the asset price bubble, and when deflation began, the real burden of debt increased as the nominal value of debt was fixed, further suppressing demand for already stagnant capital investment. At the same time, in the face of an effective lower bound on nominal interest rates, rising deflationary expectations also suppressed firms' demand for capital investment as the real interest rates remained high. Through these mechanisms, persistent deflation and deflationary expectations suppressed demand for capital and pushed down the capital-labor ratio, leading to a negative impact on LP.

Then, it is also worth asking whether recent rises in inflation and inflation expectations stimulate demand for capital investment. Since Japanese firms' balance sheet burden has already been alleviated (balance sheet adjustments), it is difficult to assume that the above mechanisms during the deflation period are currently working in the opposite direction. As long as nominal interest rates remain low and stable, the gradual rise in inflation expectations stimulate demand for capital investment through a fall in real interest rates,[34] but this may not be the case if inflation expectations rise significantly beyond the "price stability target." In this regard, according to a survey of corporate behavior (Bank of Japan [2024a]), some firms indicate that moderate inflation would enable them to make positive fixed investments. An analysis using firm-level data after 2014 in the *Tankan* survey (Short-Term Economic Survey of Enterprises in Japan), in which each firm's fixed investment is regressed on the firm's inflation outlook and other explanatory variables (such as sales and various judgment survey items), shows that firms that expect moderate inflation (up to around 2.5 percent) significantly increased their fixed investment.[35] While the degree and detailed mechanisms are not necessarily clear, a gradual rise in inflation expectations can have a positive impact on LP through capital investment.

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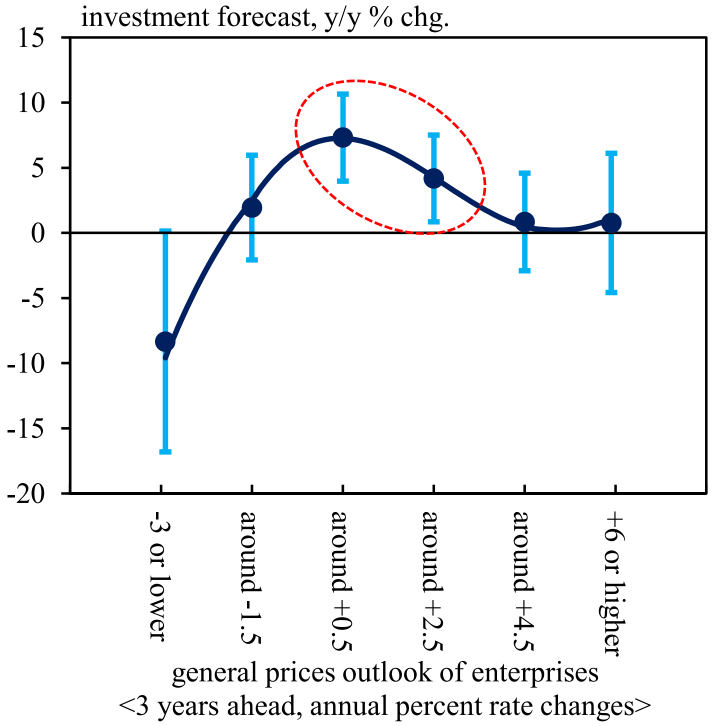
[34] The stagnant demand for capital investment in recent years in Japan has been strongly influenced by structural factors such as sluggish domestic growth expectations and shifts to overseas production. How much of these factors can be counteracted by a decline in real interest rates through a moderate rise in inflation expectations remains to be assessed quantitatively.

[35] The "Binscatter" method by Cattaneo *et al*. [2024] is used in the estimation. Figure 20 plots the estimated year-on-year percentage change in fixed investment on the vertical axis, for each segment of inflation outlook on the horizontal axis (divided into segments to aggregate multiple responses for ensuring the stability of the estimation results), along with the 95 percent confidence intervals and a polynomial approximation using a non-linear function, assuming that other explanatory variables take their mean value. For details, see Appendix 2 of Fukunaga, Hogen, and Ueno [2024].

(Figure 20) Inflation expectations and fixed investment (Firm-level *Tankan* data)



Source: Fukunaga, Hogen, and Ueno [2024].
Note: The estimation period is from March 2014 to December 2023 (frequency: quarterly). The vertical lines represent the 95 percent confidence interval.

4-2. Innovation in a low-inflation environment

In this subsection, we discuss the relationship between inflation and types of innovation. This paper considers two main types of innovation by firms: "product innovation" which introduces new goods and services to the market, and "process innovation" which introduces new business processes within the firm. The former is often interpreted as demand-enhancing and having a positive impact on prices, while the latter is often interpreted as cost-cutting and having a negative impact on prices. According to a survey of firms and cross-country studies,[36] the ratio of demand-enhancing product innovation has been declining (while the ratio of cost-cutting process innovation has been rising) in Japan since the 2000s and lower than in other developed countries. This trend has also

[36] Survey of Japanese firms refers to the National Innovation Survey conducted by the National Institute of Science and Technology Policy, an organization affiliated with the Ministry of Education, Culture, Sports, Science and Technology. The survey conforms to the "Oslo Manual," an international guideline for collecting, reporting and using data on innovation, and the results are provided to the OECD. The OECD Business Innovation Indicators, which include the above-mentioned Japanese results, are used for international comparisons.

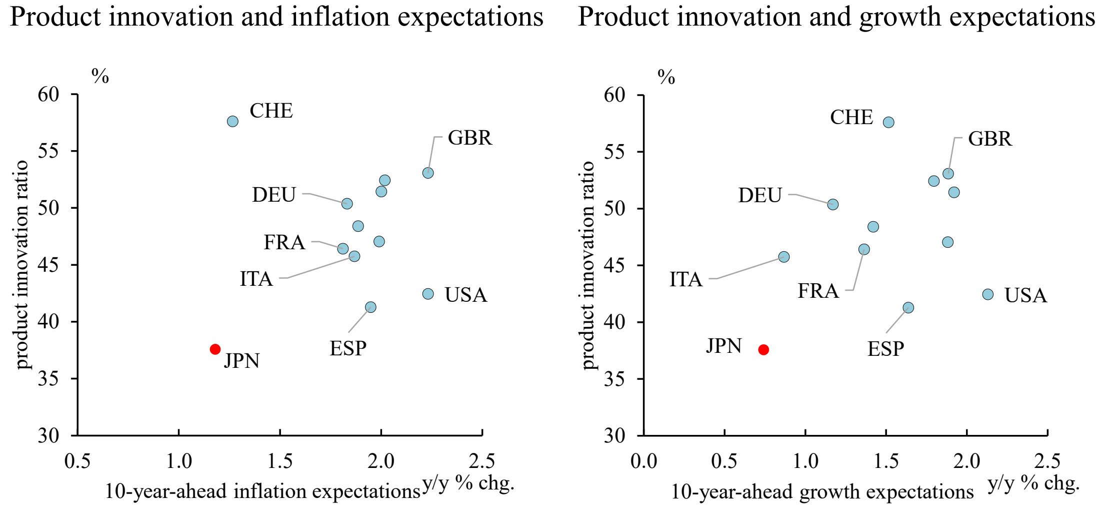
been pointed out as one of the reasons for Japan's low inflation.[37]

Furthermore, as the other causal direction, it is also pointed out that the persistence of low inflation and inflation expectations themselves might have had an impact on the types of innovation. In Japan, since the mindset and practices based on the assumption that wages and prices would not rise have taken root as a social norm, firms were focusing more on cutting costs of existing products rather than developing new products for which they were unsure whether they would be able to set a price that would cover their costs. As mentioned in the previous subsection, many firms have perception that moderate inflation enables them to make positive investment, but a state in which prices hardly change discourage them from doing so. If the low inflation expectations themselves caused a shift toward process innovation, this would lead to further downward pressure on prices through cost-cutting, and result in a vicious cycle leading to the entrenchment of the low inflationary environment.

The relationship between medium- to long-term inflation expectations and the ratio of product innovation in the 2010s and beyond shows that Japan's inflation expectations were lower than those of many other developed countries (around 2 percent), and that the ratio of product innovation was also lower (Figure 21, left chart). However, among the advanced economies excluding Japan (which are considered to have relatively similar industrial structures and levels of economic development), there is no clear relationship between inflation expectations and the ratio of product innovation. In particular, Switzerland (CHE) had inflation expectations that were as low as those of Japan, but had a notably higher ratio of product innovation than other countries. This implies that the bias toward cost-cutting in Japan, where low inflation became the social norm, is somewhat an exception compared to other countries. It is important to note that even if such a norm dissolves in the future, that alone will not necessarily lead to an increase in the product innovation ratio. Meanwhile, the relationship between medium- to long-term growth expectations (forecast of 10-year ahead real economic growth rate) and the ratio of product innovation among the same developed countries shows that Japan again has lower growth expectations and a lower ratio of product innovation than other developed countries (Figure 21, right chart). These observations suggest the possibility that Japanese firms' bias toward cutting costs may be related to sluggish growth expectations, and it would be useful to deepen our understanding on this point as well.

[37] On the demand-enhancing effects of product innovation, see Aoki and Yoshikawa [2007].

(Figure 21) Relationship between product innovation and inflation/growth expectations



Sources: IMF; Consensus Economics "Consensus Forecast"; OECD.

Note: The product innovation ratio is the proportion of firms that achieved product innovation relative to the total number of firms that achieved either process or product innovation. It is the average of values published by the OECD in 2015, 2017, 2019, 2021, and 2023. The reference period is 2009-2021 (varies by country). The 10-year-ahead inflation expectations and growth expectations are the averages since the 2010s.

4-3. Price markups and productivity

Lastly, given the fact that price markups are one of the key elements of inflation, we consider the relationship between price markups (the gap between sales price and marginal cost in an imperfectly competitive environment) and productivity (particularly TFP). In general, in an imperfect competition economy, output is suppressed to a lower level compared to that under perfect competition. For this reason, a reduction in price markups, which is a factor of putting downward pressure on prices, contribute to raising TFP by alleviating monopoly distortions arising from resource misallocation stemming from imperfect competition.[38] In this context, fluctuations in TFP can be decomposed into two parts: (1) a part related to price markups (including fluctuations in wage markdowns and the spillover effects across firms through production networks), and (2) a part owing to pure technological progress.[39] The latter component may be related to

[38] Baqaee and Farhi [2020] present a method for decomposing TFP into a part derived from price markups and a part derived from technological progress in a general equilibrium model that takes into account industrial linkages, and show that in the U.S., TFP has accelerated by both efficiency improvements (reducing price markups and expanding scale) and technological progress in high-price markup firms.

[39] The reallocation effect across firms and the entry and exit effects on LP discussed in Subsection 3-3 may be included in (1), and the within effect may be included in both (1) and (2). While the reallocation effect in Subsection 3-3 captures the effect of the reallocation of employed persons across firms, the resource allocation effect on TFP in this analysis captures the effect of improving the efficiency of the economy as a whole due to changes in the competitive environment, etc.

demand-enhancing product innovation as a result of R&D and investment in intangible assets.

Aoki *et al.* [2024] decompose TFP of Japan's economy since the second half of the 1990s into the above-mentioned factors: (1) changes in resource allocation due to price markups and (2) pure technological progress.[40] Their results show that the contribution of changes in resource allocation explained almost all of the increase in TFP from the second half of the 1990s to the mid-2010s, while the contribution of technological progress was limited (Figure 22, left chart). According to the results for the U.S. in Baqaee and Farhi [2020], technological progress made a solid contribution to the rise in TFP during the same period, contrasting with the results for Japan (Figure 22, right chart). This is also consistent with the international comparison of the ratio of product innovation discussed in the previous subsection. In Japan, price markups shrank during this period, putting downward pressure on prices, but at the same time, this may have been a factor underpinning productivity (TFP).[41] From the second half of the 2010s onwards, the positive contribution of changes in resource allocation has almost disappeared (price markups, which was estimated separately, have also largely stopped declining), and instead, technological progress has contributed to the rise in TFP. It is also worth noting that there is an inverse correlation between the contribution of changes in resource allocation and that of technological progress (the contemporaneous correlation is around -0.7), suggesting that technological progress is likely to stagnate when price markups decline. Taking into account this inverse correlation, the reduction in price markups, which was accompanied by downward pressure on prices, might have not only directly boosted TFP through changes in resource allocation, but also indirectly led to a decline in TFP through a slowdown in technological progress.

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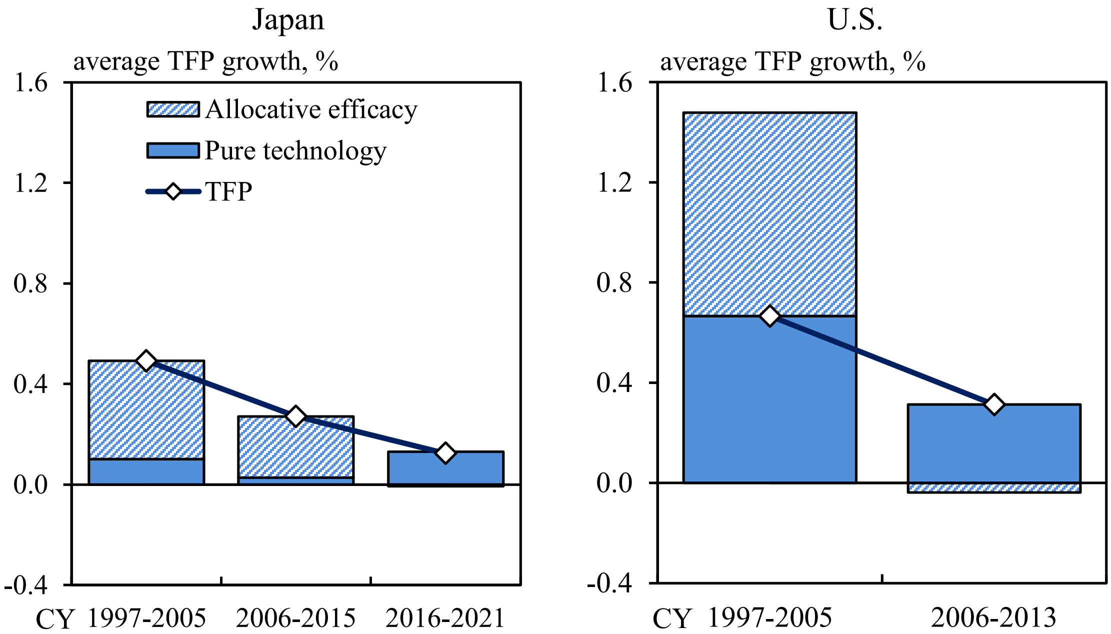
[40] Aoki *et al.* [2024] use data from the Basic Survey of Japanese Business Structure and Activities and other sources to estimate TFP and other factors. They also separately estimate price markups and wage markdowns, which are then used in the above decomposition.

[41] On the other hand, some argue that it is important to secure a certain degree of price markups in order to expand firms' capital investment (Cabinet Office of Japan [2023]).

(Figure 22) Decomposition of TFP growth



Source: Aoki et al. [2024].
Note: Data for the U.S. are calculated based on Baqaee and Farhi [2020].

5. Conclusion

In this paper, we looked back on the background of the sluggish potential growth and the slowdown in LP growth since the 1990s, and raised some issues on their concepts and measurement, as well as on their relationship with prices and wages. Specifically we pointed out that (1) there is a great deal of uncertainty in estimating the potential growth rate due to differences in approaches; (2) a decline in the potential growth rate could be accompanied by an even sharper decline in aggregate demand, leading to a worsening of the output gap; (3) the slowdown in LP growth, combined with the decline in the labor share and the deterioration in the terms of trade, has exerted downward pressure on real wages; (4) the slowdown in LP growth has also led to upward pressure on prices through rising ULC; and (5) the prolonged deflation and low inflation themselves might have adversely affected productivity through suppressing demand for capital investment and other factors.

While the sluggishness of the potential growth and slowdown in LP growth are serious problems in themselves, monitoring these trends is also necessary for conducting monetary policy with the aim of maintaining price stability. It is also important to look at the relationship between productivity, prices, and wages from a variety of perspectives, while being mindful of the uncertainties in these estimates. At the current juncture, it is particularly worth paying attention to how the trends of prices, wages, and productivity will change in response to changes in economic structure and global landscape following the COVID-19 pandemic.

Appendix 1: Alternative approaches for estimating the potential growth rate[42]

(Structural VAR model)

The production function approach explained in Section 2 is widely used by policy practitioners in many countries as a method for estimating the potential growth rate and the output gap, but there are also critiques and suggestions for alternative approaches from academia. For example, Coibion, Gorodnichenko, and Ulate [2018] analyzed the background to the fact that the U.S. potential growth rates estimated by the CBO and other organizations was revised downward repeatedly over a period of nearly ten years after the global financial crisis (GFC) in 2008. They pointed out the possibility that these organizations might have mistakenly identified cyclical shocks on the demand side (such as monetary policy shocks) as supply shocks and were slow to identify persistent shocks on the supply side that should be reflected in the potential growth rate.

Coibion, Gorodnichenko, and Ulate [2018] propose an alternative approach that overcomes the problems of the production function approach by using structural vector auto-regressive (VAR) models such as those of Blanchard and Quah [1989]. The model identifies temporary and permanent (persistent) shocks to real GDP, and the cumulative impact of the latter is assumed to be the potential GDP. According to this approach, the downward revisions of the estimated U.S. potential growth rate converged a few years after the GFC, and only a limited part of the downward shift in real GDP growth could be attributed to a decline in the potential growth (while the remainder was captured as a negative output gap).

In this paper, we apply this approach to Japanese data. The data used for estimation are real GDP (seasonally adjusted, quarter-on-quarter rate of change, $\Delta \mathrm{y_t}$) and the active job openings to applicants ratio (quarter-on-quarter change, Δu_t). The sample period is from the first quarter of 1979 to the fourth quarter of 2023. The structural VAR model is expressed by the following two equations.

$$\Delta \mathrm{y_t} = \phi_{yD,0}\Delta u_t + \sum_{j=1}^{k} \phi_{yS,j}\Delta y_{t-j} + \sum_{j=1}^{k} \phi_{yD,j}\Delta u_{t-j} + \epsilon_t^S,$$

[42] Fueki *et al.* [2010] discuss various approaches to estimate the potential growth rate, including "filtering approach" and "Phillips curve approach" in addition to the approaches discussed in this paper.

$$\Delta u_t = \phi_{uS,0}\Delta y_t + \sum_{j=1}^{k} \phi_{uS,j}\Delta y_{t-j} + \sum_{j=1}^{k} \phi_{uD,j}\Delta u_{t-j} + \epsilon_t^D,$$

where k denotes the lag order (set to 3 quarters based on AIC), ϵ_t^S, ϵ_t^D denotes supply and demand shocks, respectively. Following Blanchard and Quah [1989], we identify the above structural VAR by assuming that the demand shock ϵ_t^D does not affect potential growth in the long run.

(DSGE model)

Another approach taken by academia and some central banks to estimate the potential growth rate uses DSGE (dynamic stochastic general equilibrium) models, in which greater emphasis is put on the consistency with economic theory.[43] In the New Keynesian theory on which these models are based, the gap between the actual real GDP (which is affected by various shocks through price and nominal wage rigidities) and the "natural" level of output (which is defined as a hypothetical level of output under flexible prices and not affected by monetary policy shocks) drives inflation dynamics (the New Keynesian Phillips curve). In this theory, fluctuations in the natural level of output correspond to the potential growth rate. Since both demand-side and supply-side shocks (excluding monetary policy shocks) can affect the natural output in many DSGE models, it is not appropriate to interpret the gap from the natural output as an indicator of the supply-demand balance in the economy.

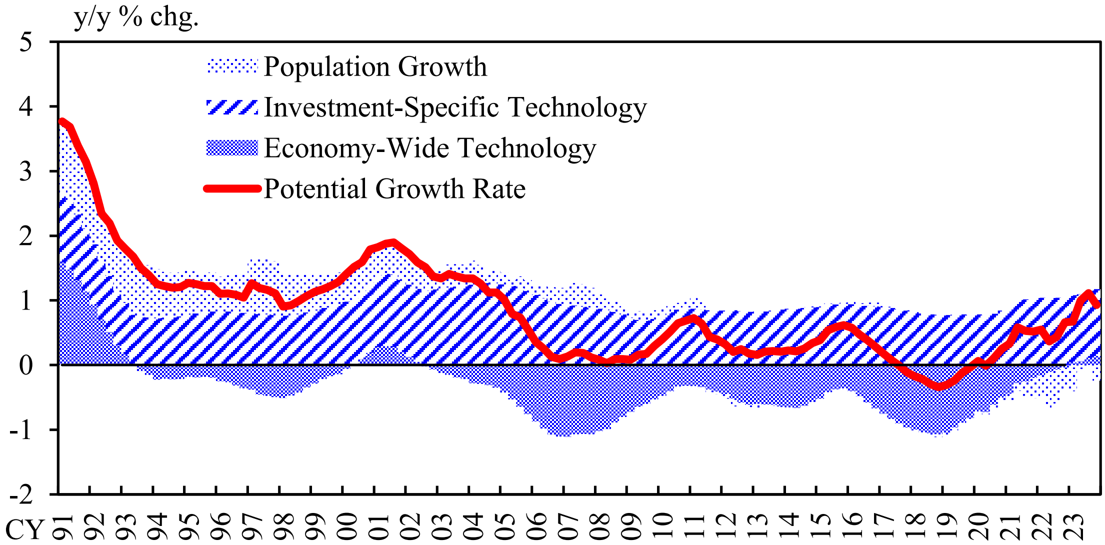
In this paper, we update the estimates of potential growth rate and output gap using one of the DSGE models developed in the Research and Statistics Department of the Bank of Japan (Fueki *et al.* [2016]) to the fourth quarter of 2023. In Fueki *et al.* [2016], in order to bridge the gap between DSGE model-based and conventional (based on the production function approach) measures, the potential growth rate is defined as a component of fluctuations in the natural output generated only by persistent supply shocks, and the output gap is defined as the gap between this persistent or "long-run" component of natural output and the actual GDP.[44] In fact, the trends of these DSGE model-based measures of potential growth rate and output gap are generally similar to those of the measures based on the production function approach (see Figures 4 and 5 in the main

[43] For example, Edge, Kiley, and Laforte [2008] in the Federal Reserve Board estimate the U.S. potential growth rate and the natural rate of interest using a DSGE model.

[44] Fueki *et al.* [2016] confirm that the output gap defined in this way has good predictive power for inflation, even though it does not exactly correspond to the theory of the New Keynesian Phillips curve.

text). This DSGE-model based potential growth rate can be decomposed into the effects of persistent supply shocks on the fast-growing sector (producing investment goods, etc.) and on the slow-growing sector (producing consumption goods, etc.) as well as the effects of (exogenous) population growth. According to the decomposition (Figure A1), the decline in the potential growth rate in the 1990s and the sluggishness since the 2000s are explained to a large extent by a supply shock to both sectors (an economy-wide technology shock), rather than by a supply shock specific to the fast-growing sector (an investment-specific technology shock).[45] This result may imply that the fast-growing sector has been continuously increasing productivity while suppressing employment, partly because it has always been exposed to global competition, but there has been little impetus to raise productivity of the slow-growing sector as well, which include many labor-intensive industries. In addition, the slowdown in population growth since the 1990s has also contributed to the continuous decline in the potential growth rate.[46]

(Figure A1) Decomposition of the potential growth rate (DSGE model)



Note: An updated version of Figure 3 from Fueki et al. [2016], using data up to 2023/Q4.

45 Shirota and Tsuchida [2024], using a different approach from the DSGE model, decompose the long-run trend growth rate of the economy into industry-specific factors and factors common to the economy as a whole. They show that the common factors were the main contributors to the decline in the long-run trend growth rate of Japan's economy, while the industry-specific factors have remained relatively stable.

46 The model is estimated using data such as GDP and private consumption per population aged 15 and over. Changes in the population aged 15 and over are added to the potential growth rate as an exogenous factor. Other demographic factors such as the effects of population aging may be separately captured by persistent supply shocks in the model.

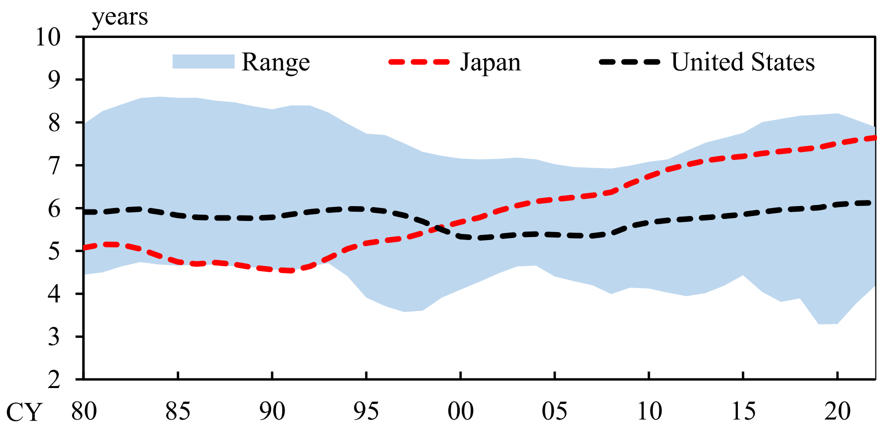
Appendix 2: Factors of the slowdown in labor productivity growth since the 1990s

As discussed in Section 3 of the main text, various factors have been pointed out in the literature as the background to the sluggish growth in Japan's labor productivity (LP) since the mid-1990s. In this appendix, we briefly summarize the relevant discussions in the following order: (A) sluggish growth in domestic capital investment, (B) insufficient investment in IT and intangibles and their utilization, (C) changes in industrial structure and stagnant reallocation across firms, (D) labor market rigidities, (E) population aging, (F) globalization, (G) regulations, and (H) corporate governance.

(A) Sluggish growth in domestic capital investment

In the literature, slowdown in the growth of the capital-labor ratio is identified as one of the main reasons for the slowdown in the LP growth in Japan (Goldin *et al.* [2024]). Following the collapse of the asset price bubble in the early 1990s, the adjustment of the excess capital stock began, and capital investment has remained sluggish for a long time since then. In addition to the decline in firms' growth expectations, the factors pointed out include the impact of the financial crisis in the second half of the 1990s (pressure to improve financial soundness due to experience of credit crunch, etc.), securing cash and deposits in preparation for uncertainty, and shift to overseas investment.[47] The slump in capital investment is also reflected in the fact that the vintage (average age) of the capital stock has been rising markedly compared to other countries (Figure A2).

(Figure A2) Vintage of capital stock



Source: Bergeaud, Cette, and Lecat [2016] and their "Long-term Productivity Database (v2.6)."

Note: The shaded area represents the maximum and minimum values of capital stock vintages from 24 countries and regions. The most recent data is as of CY2020.

[47] Bank of Japan [2024a] surveyed Japanese firms about the reasons for the pace of increase in domestic fixed investment having remained moderate relative to that of improvement in cash flow since the mid-1990s, in which various reasons are cited including the factors listed above.

(B) Insufficient investment in IT and intangibles and their utilization

Since the 1990s, the importance of intangible assets (such as intellectual assets and human capital) has increased in many countries, and in the U.S. in particular, industries that are highly dependent on intangible assets, such as the IT industry, have greatly increased productivity, bringing about various changes in the economy (Haskel and Westlake [2018], Corrado *et al.* [2021]). In Japan, R&D and software investment are increasing, but it has been pointed out that investment in human capital is particularly low compared to other developed countries (Yagi, Furukawa, and Nakajima [2022]). Regarding IT investment in Japan, it has been pointed out that the country fell behind the U.S. in investment during the 1990s and 2000s due to the prolonged effects of the bursting of the bubble economy and the financial crisis.

In Japan, there were problems not only with investment in intangible assets but also with their utilization. For example, it has been pointed out that there were fewer initiatives in Japan than in other countries to raise LP by using human capital in a complementary manner with IT and R&D stocks (Fukao, Kim, and Kwon [2021]).

(C) Changes in industrial structure and stagnant reallocation across firms

In many countries, as income levels rise and the economy becomes more service-oriented, employment shifted from the manufacturing industry, where LP growth is high, to the non-manufacturing industry, where LP growth is relatively low, and as a result, the LP growth in the economy as a whole is suppressed. However, as discussed in Subsection 3-2 of the main text, the effect of such reallocation across industries was not very large in Japan from the 1990s onwards. On the other hand, as discussed in Subsection 3-3, the negative contribution to LP growth due to the reallocation effect across firms may have been significant. It has also been pointed out that the rates of business opening and closing in Japan are significantly lower than in other developed countries such as the U.S.

(D) Labor market rigidities

The so-called Japanese-style employment practices are characterized by seniority-based wages and lifetime employment, and during the period of rapid economic growth in the 1960s, these were seen as an important mechanism for prosperity. However, since the bursting of the asset price bubble in the 1990s, it has been pointed out that the rigidities in this mechanism have led to stagnant resource reallocation across industries and firms (Fukao and Kim [2023]). In addition, while Japanese-style employment practices have been maintained for full-time employees, non-regular employment expanded after the

1990s, leading to a lack of human capital investment through a reduction in education and training.[48]

(E) Population aging

In general, the impact of aging on LP has both negative and positive aspects, and the total impact is not necessarily clear (Lee [2016]). The negative aspects include the effects on LP through a decline in individual ability due to the aging of workers and managers, a reduction in capital investment due to concerns about the lack of successors and business continuity, a decline in the rate of firm entry (Hopenhayn, Neira, and Singhania [2022]), and a shift to the service industry with relatively low productivity (Cravino, Levchenko, and Rojas [2022]). The positive aspects include the substitution of labor for capital through robotization and automation (Acemoglu and Restrepo [2017, 2022]). In Japan, it is also possible that the negative effects in the past will be mitigated as the aging of the workforce stops in the future.

(F) Globalization

In general, it has been recognized that globalization leads to increased productivity through the spread of knowledge, the promotion of research and development, the efficient allocation of resources, and access to inexpensive intermediate goods and production factors. However, since the 1990s, Japan's competitiveness has declined compared to the emerging economies of Asia, and its LP growth has been lower than that of other developed countries such as the U.S. (Figure 10 in the main text), which may imply that Japan has not been able to fully enjoy the benefits of globalization.[49] In particular, while highly productive firms were expanding overseas, inward foreign direct investment was sluggish, suggesting that the reallocation of resources across borders had a negative impact on Japan's domestic productivity.

(G) Regulations

In general, some government regulations are introduced with the aim of improving market functions, but on the other hand, they also inhibit the entry and exit of firms and suppress the reallocation of resources across firms, so deregulation has been promoted in many countries. In Japan, after the yen appreciated in real terms around the mid-1990s,

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[48] In addition to the fact that non-regular workers received little training from their firms, there was also a problem of mismatch between their skills and available jobs (Morikawa [2017]).

[49] For more on the effects of globalization on Japan's economy, see Hogen *et al.* [2024].

deregulation progressed in all areas of the non-trading industries (electricity, telecommunications, wholesale, retail, transport, etc.) with the aim of correcting (narrowing) price differentials between domestic and foreign markets and returning its benefits to the general public. As a result, as we saw in Subsection 3-2, the LP growth in the non-manufacturing industry in the 2000s increased, particularly in the wholesale and retail industry where deregulation had progressed, but these effects have begun to wear off in the 2010s. As is expressed by the term "bedrock regulations," there are still areas where deregulation has not progressed, and Japan has not been evaluated as having made progress in deregulation compared to other developed countries (it is below average in OECD indicators).[50]

(H) Corporate governance

Looking back on the long-term trends in corporate governance in Japan, before the bubble economy, there was an emphasis on monitoring of management by stakeholders through the building of various long-term relationships with those providing funds (main banks, cross-shareholdings), employees (lifetime employment, boards of directors made up of internal promotions), and business partners (production and distribution chains). After the bubble burst and the financial crisis in the 1990s, firms reduced their dependence on banks for funding and gradually shifted to a market-based governance structure (Miyajima and Saito [2019, 2023]).[51] In the 2010s, corporate governance reform has progressed further, with the Stewardship Code established in 2014 and the Corporate Governance Code established in 2015, and market-based governance structures have been further strengthened. However, it has been pointed out that under this market-based governance structure, management may become short-sighted, focusing on the interests of shareholders in the near term, and this could lead to a decline in productivity (Lazonick [2014]).[52] In Japan, as in other developed countries, there have been indications that share buybacks and dividend payout ratios have increased, but capital investment, R&D

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[50] In the OECD's "Economy-wide Product Market Regulation Indicators" (a measure of the regulatory and market environment across the economy), Japan's regulatory index is higher than the OECD average (indicating a high level of regulation). This index is calculated based on responses to a questionnaire covering more than 1,000 items related to cross-market regulations and regulations in specific industries. For more information, see OECD [2024].

[51] Since 1997, the legal system relating to firm activities has been gradually revised with the aim of transitioning to a market-based governance structure. Some believe that, in the 1990s, as the role of the main bank declined, a temporary vacuum in corporate governance arose due to the lack of alternative capital market discipline.

[52] In U.S. firms where top management salaries are linked to firm performance, it has been pointed out that share buybacks and other such measures take priority over long-term investments to improve productivity.

investment, and human resource investment have not increased.[53] On the other hand, some believe that these reforms were insufficient for SMEs (especially family-run businesses), and that the focus on ensuring the survival of these businesses resulted in a lack of growth in productivity.

[53] See Miyajima and Saito [2019, 2023] and Jidinger and Miyajima [2020].

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