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Sohei Kaihatsu [*]
souhei.kaihatsu@boj.or.jp

Noriyuki Shiraki[**]
noriyuki.shiraki@boj.or.jp

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Bank of Japan
2-1-1 Nihonbashi-Hongokucho, Chuo-ku, Tokyo 103-0021, Japan

[*] Monetary Affairs Department (currently Research and Statistics Department)
[**] Monetary Affairs Department (currently International Department)

Firms' Inflation Expectations and Wage-setting Behaviors*

Sohei Kaihatsu† Noriyuki Shiraki‡

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Abstract

This paper aims to examine the formation mechanism of firms' inflation expectations and the relationship between those expectations and wage-setting behaviors. We conduct an empirical analysis based on microdata constructed by matching a business survey for inflation expectations and corporate financial data. Our empirical results demonstrate that firms' short-term and medium- to long-term inflation expectations have significantly increased after the Bank of Japan introduced a price stability target of two percent and quantitative and qualitative monetary easing in 2013. During this period, dispersions of distributions of inflation expectations increased temporarily and then shrank again. These changes vary across business attributes, such as the size of a firm. Therefore, differences in business attributes might result in the heterogeneous reaction of inflation expectations to monetary policy shocks. Furthermore, an empirical analysis using the data from 2004 to 2016 shows that (a) both wages and short-term inflation expectations tend to increase along with medium- to long-term inflation expectations and (b) both wages and operating profits tend to decrease when only short-term inflation expectations increase. The result implies that a balanced economic growth between prices and wages can be achieved when there is an increase in a wide range of firms' medium- to long-term inflation expectations.

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Keywords: firm's inflation expectation, wage-setting behaviors, quantitative and qualitative monetary easing, panel VAR

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† Monetary Affairs Department, Bank of Japan (currently Research and Statistics Department, souhei.kaihatsu@boj.or.jp)

‡ Monetary Affairs Department, Bank of Japan (currently International Department, noriyuki.shiraki@boj.or.jp)

1. Introduction

As exemplified by Keynes (1923), the influence of inflation expectations on current inflation rates has been an important issue in economic analyses[1]. In the canonical New Keynesian model, inflation expectations affect current inflation rates via the dynamic optimization behaviors of economic agents. With theoretical and empirical interests forming the backdrop, inflation expectation has continued to be an important research topic. In particular, central banks have conducted intensive research regarding inflation expectations' formation mechanisms because they are thought to be practically important for achieving a price stability target.

In recent years, the study of inflation expectations has become more significant for central banks facing the stronger trends of disinflation and deflation in major countries. For instance, the Bank of Japan introduced a price stability target of two percent and "Quantitative and Qualitative Monetary Easing" (QQE) in 2013[2]. In January 2016, the Bank then introduced "Quantitative and Qualitative Monetary Easing with a Negative Interest Rate" to achieve the price stability target at the earliest. These policies aim to raise inflation expectations, which have steadily declined during the deflationary period of nearly 15 years. Thus, monitoring inflation expectations and implementing appropriate policies based on an understanding of the formation mechanism of inflation expectations have become increasingly vital for the Bank.

Notwithstanding its importance as an issue in monetary policy implementation, our understanding of inflation expectations has remained limited. As Kuroda (2015) mentioned, various important issues regarding inflation expectations need to be studied further: (1) how to measure inflation expectations; (2) how inflation expectations are formed; and (3) how policy measures affect them[3]. For example, a number of

[1] "If prices are expected to rise and the business world acts on this expectation, that very fact causes them to rise for a time and, by verifying the expectation, reinforces it; and similarly, if it expects them to fall" (Keynes, 1923, p. 34).

[2] Hereinafter, "QQE" stands for the sequence of the two policy decisions: the introduction of a price stability target of two percent and the Quantitative and Qualitative Monetary Easing.

[3] Kamada *et al.* (2015) and Ito and Kaihatsu (2016) studied inflation expectations in Japan's households sector. Furthermore, Kaihatsu and Nakajima (2015) studied trend inflation corresponding to long-term inflation expectations in Japan.

methodologies can be used for measuring inflation expectations: (a) extracting trends from actual inflation rates; (b) measuring expectations based on inflation-indexed bond yields; and (c) conducting surveys for economic agents such as households and firms. However, different measures of inflation expectations have different level and fluctuation characteristics. Due to our limited knowledge of those characteristics, monitoring inflation expectations in real-time is a difficult task.

The literature, particularly regarding firms' inflation expectations, is sparse. Firms' inflation expectations, which affect prices, employment, and capital investment, are directly associated with monetary policy through an influence on real interest rates. Yet, there has been less empirical research on the inflation expectations of firms than those of households, financial markets, and economists.

In this paper, based on microdata from a survey of publicly listed firms from 2004 to 2016, we examine the key aspects of firms' inflation expectations and their formation mechanism. We subsequently perform empirical analyses of the relationship between inflation expectations and wage-setting behaviors by matching the survey and corporate financial data. The analysis period encompasses both the deflationary period and the period of rising inflation expectations following the introduction of QQE.

This paper is notable in three aspects. First, we examine the term-structure of inflation expectations based on the "Annual Survey of Corporate Behavior." As this survey collects data on both short-term (next fiscal year) and medium- to long-term (next five fiscal years) inflation expectations, we can analyze the relationship between those expectations and their determinants.

Second, we use a parametric method to estimate the distribution of inflation expectations and examine the gradual changes in distribution. An examination of how distributions of inflation expectations change under the economic shocks, such as monetary policy changes, yields suggestions regarding inflation expectations' formation mechanisms. Moreover, we can assess the stability of inflation expectations based on distributional variances. The Bank of Japan, in particular, has been conducting large-scale monetary easing since 2013 with the intent of increasing inflation expectations. Statistical examinations of the changes in the distribution of inflation

expectations before and after the policy change can provide key insights about the relationship between monetary policy and inflation expectations.

Third, we employ Panel Vector Auto Regression (PVAR) to examine the dynamic relationship between inflation expectations and wage-setting behaviors. Bernanke (2007) claims that medium- to long-term inflation expectations have a greater influence on both price- and wage-setting behaviors compared with short-term expectations. In this paper, we use PVAR to analyze both the dynamic interrelationship between short-term and medium- to long-term inflation expectations and its influence on wage-setting behaviors. Furthermore, by exploiting the cross-sectional heterogeneity in individual firms, PVAR enables us to analyze the interdependencies among variables even with relatively short time series data.

This paper is organized as follows: Section 2 provides an overview of the inflation expectations survey and describes the data used in this paper; Section 3 explains the parametric estimation method used to analyze changes in the distribution of inflation expectations before and after the introduction of QQE; Section 4 analyzes the dynamic relationship between inflation expectations and wage-setting behaviors based on the PVAR analysis; and Section 5 provides concluding remarks.

2. Outline of the Data on Firms' Inflation Expectations

2.1 Surveys of firms' inflation expectations

Central bank practitioners emphasize the stability of medium- to long-term inflation expectations against the background of theoretical and empirical findings (Kuroda, 2015; Yellen, 2015). From a theoretical perspective, inflation expectations in a forward-looking model with rational expectations correspond to the expectations in an infinite horizon. It has been empirically reported that long-term inflation expectations influence actual inflation rates more than short-term inflation expectations (Clark and Davig, 2008).

Thus, central banks and other institutions have conducted surveys of medium- to long-term inflation expectations. For example, with regard to households, the Bank of Japan has its "Opinion Survey on the General Public's Views and Behavior," which

covers current inflation perceptions and one-year- and five-year-ahead inflation expectations. The University of Michigan's "Survey of Consumers" covers one-year- and five-to-ten-year-ahead inflation expectations. With regard to economists, the "Survey of Professional Forecasters," from the Federal Reserve Bank of Philadelphia, covers from one-year- to ten-year-ahead inflation expectations.

In contrast, few examples of regularly conducted business surveys for long-term inflation expectations, at least among major countries, exist and therefore research about firms' inflation expectations is scarce[4]. Against this backdrop, central banks of major countries have recently started expanding surveys of firms' inflation expectations. For example, the Federal Reserve Bank of Atlanta kicked off its "Business Inflation Expectations Survey" in 2011, in which it surveys firms' inflation expectations not only for the short-term (one-year-ahead) but also the medium- to long-term (five-to-ten-year-ahead). In 2013, the Bank of Japan also began collecting data on firms' inflation expectations in short-term and medium- to long-term horizons (one-, three-, and five-year-ahead) as a part of the "Short-Term Economic Survey of Enterprises in Japan" (*Tankan*).

2.2 Overview of the data used in the estimation

The analyses of this paper are based on microdata of the "Annual Survey of Corporate Behavior" (ASCB), provided by the Cabinet Office's Economic and Social Research Institute (ESRI). This survey has been conducted by the ESRI since 1961 and samples firms listed on the First and Second Sections of the Tokyo and Nagoya Stock Exchanges (size of population is 2,515 for the January 2016 survey). The effective response rate has recently reached around 40%.

To the best of our knowledge, ASCB is the only such survey in Japan that enables an examination of short-term and medium- to long-term firms' inflation expectations over a relatively long period. Inflation expectations from 2004 onward can be analyzed through

[4] Rare exceptions are the Bank of Canada's "Business Outlook Survey," conducted since 1997, and the Reserve Bank of New Zealand's "Survey of Expectations," conducted since 1987. However, they collect data on rather short-term inflation expectations (up to two-years-ahead).

this survey, which encompasses both the deflationary period and the period of rising inflation expectations after the introduction of QQE[5]. It also facilitates an analysis by considering firm heterogeneity since it includes panel data.

This paper utilizes two features of inflation expectations. The first is that, while ASCB actually collects data on the expected growth rates for nominal and real GDP, we obtain inflation expectations indirectly by subtracting expected real growth rate from expected nominal growth rate. The second is that inflation expectations in this paper correspond to expectations for the GDP deflator. Fluctuations in and levels of inflation expectations may vary depending on price concepts. For example, as shown in Figure 1, the growth rate of GDP deflator is consistently lower than that of the consumer price index (CPI). Moreover, around the time of the 2009 financial crisis, the indicators even moved in different directions[6]. Such differences in survey methodologies and price concepts must be carefully noted when comparing inflation expectations as defined here with the results of other surveys.

2.3 Definition of short-term and medium- to long-term inflation expectations

In this paper, we explicitly distinguish between short-term and medium- to long-term inflation expectations by calculating forward rates for the latter. As shown in Figure 2, ASCB collects data on three types of expectations in varying terms: (1) over the next year, (2) over the next three years, and (3) over the next five years. We denote the inflation expectations over the next year as short-term and a forward rate from one to five years ahead as medium- to long-term. The forward rate can be calculated as follows. Given a spot rate π_n for n periods ahead from the present and a spot rate π_{n+m} for $n+m$ periods ahead from the present, the forward rate $\pi^F_{n,m}$ from period n to period $n+m$

[5] In this paper, the timing of the ASCB is considered according to calendar year. For example, we denote "CY2004"as the January 2004 survey, whereas the official release by ESRI is based on the fiscal year; thus, the years in this paper are shifted one year ahead of that of the official release.

[6] Differences between the CPI and the GDP deflator could be due to the following: (a) the GDP deflator also reflects the investment deflator and terms of trade, or (b) the GDP deflator is a chained index while the CPI is a fixed-base index. Actually, as in Figure 1, the final consumption deflator, that corresponds to CPI conceptually, moves in parallel with the CPI.

is defined as

$$\pi_{n,m}^{F} = \left(\frac{(1+\pi_{n+m})^{n+m}}{(1+\pi_{n})^{n}} \right)^{1/m}.$$

In this paper, we use $n = 1$ and $n + m = 5$. Note that the medium- to long-term inflation expectations computed as forward rates are "average inflation expectations from one year ahead to five years ahead" obtained by removing the short-term inflation expectations component. As mentioned in the previous section, short-term and medium- to long-term inflation expectations may differ in their formation mechanisms and influences on the real economy. Moreover, it is appropriate to explicitly remove short-term factors, such as one-off changes in tax rates, in some cases when considering long-term inflation expectations. Using a forward rate enables us to explicitly distinguish between short-term and medium- to long-term inflation expectations.

3. Distributional Changes in Inflation Expectations

3.1 Changes in average values over time

Figure 3(1) illustrates the actual inflation (GDP deflator) and the short-term and medium- to long-term inflation expectations calculated from the aggregate values. The data period includes surveys from January 2004 to January 2016, a period for which both the nominal and real expected growth rates are available[7]. All series are negative from 2004 to 2013 and then turn positive in 2014, thus indicating the possibility that the weakening of the yen in the last half of 2012 and introduction of QQE in 2013 pulled up both the actual and expected inflations. It is worth noting that the consumption tax hike in fiscal 2014 influenced inflation expectations.

Next, we examine the relationship between short-term and medium- to long-term inflation expectations. In almost all periods, except for 2009 and 2014−2015, medium- to long-term inflation expectations exceed the short-term ones. For 2009, this could reflect

[7] In the January 2016 survey, the submission deadline was January 15. Hence, the survey does not include the effect of "Quantitative and Qualitative Monetary Easing with a Negative Interest Rate," which was introduced on January 29, 2016.

the sharp drop in short-term expected real growth rates due to the impact of the Great Recession. Furthermore, the spike in world commodity prices in 2006−2008 might have a delayed effect on short-term inflation expectations in 2009. For 2014−2015, it is possible that rising inflation expectations after the introduction of QQE were initially considered to be a rise in short-term expectations and then gradually came to be considered a longer-term change.

We finally consider the relationship between actual GDP deflators and inflation expectations[8]. Examining the gradual movement of both series, we observe that both short-term and medium- to long-term inflation expectations were consistently higher than actual values during 2004−2013, whereas both inflation expectations have been lower than the actual inflation since 2014. This is consistent with an imperfect information model that assumes some kind of stickiness in inflation expectation formation, such as Mankiw and Reis' (2002) sticky information model or Sims' (2003, 2006) rational inattention hypothesis. In other words, it is possible that gathering information incurs a certain cost that causes a lag in revisions to inflation expectations.

3.2 Estimation method

In this section, we examine changes in the shape of the distribution of inflation expectations at each point in time to analyze the background of fluctuations in inflation expectations in more detail. Observing the distributional change in inflation expectations is important in two regards. First, we can derive implications about the formation mechanisms of inflation expectations by analyzing how their distribution changes in response to economic shocks, such as changes in monetary policy. For example, Mankiw *et al.* (2004) insist that during the period of the so-called "Volcker disinflation," the distribution of inflation expectations gradually shifted with an increase in dispersion; they further propose that this evidence is consistent with a sticky information model. Second, we can argue about the stability of inflation expectations being dependent on

[8] The level of inflation expectations from the survey could differ significantly depending on the format of the survey instrument (questionnaire) as Bryan *et al*. (2015) indicate. It is necessary, therefore, to investigate and compare inflation expectations using different survey instruments to derive general implications about relationships between actual and expected inflation.

dispersion magnitude. In particular, research on stability of inflation expectations has been advancing in the monetary policy field because it is closely related to inflation targeting issues. For example, Capistrán and Ramos-Francia (2010) report that in major countries the dispersion in inflation expectations decreases after inflation targeting is introduced, thus making such policies effective anchors for inflation expectations.

Two approaches can be used to analyze changes in the shape of distributions: non-parametric methods, which compare descriptive statistics without assuming a specific distribution behind the data, and parametric methods, which assume the specific distribution in advance. The former is robust as it does not depend on any assumption about distribution; however, it has the drawback of having low accuracy when identifying changes in the distribution. Since this paper aims to examine distributional changes before and after the introduction of QQE, we chose the parametric method that has greater accuracy of detection. Following Kamada *et al.* (2015), specifically, we assume the Normal Inverse Gaussian (NIG) distribution to be a latent distribution behind the data on inflation expectations and estimate the distribution parameters based on the maximum likelihood method.

When estimating distribution parameters, we explicitly adjust the histogram's shape for the distortion observed in the responses, as in Kamada *et al.* (2015). The histogram of short-term inflation expectations in Figure 4 illustrates that responses are distorted, that is, they are clustered at multiples of 0.5%[9]. To adjust for the distortions, we assume that a certain proportion of latent responses from the region (±0.25%) are clustered at multiples of 0.5% and estimate the distortion parameters simultaneously with the NIG distribution parameters[10]. We separately estimate the parameters for short-term and medium- to long-term inflation expectations and for each survey round and examine changes in the descriptive statistics. See the Appendix for details of the estimation.

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[9] This feature is also observed in the distribution of medium- to long-term inflation expectations.

[10] Using survey data of Japanese households' inflation expectations, Kamada *et al.* (2015) estimate the distortion parameters corresponding to the following four distortions: there are (i) too many integers, (ii) zeroes, and (iii) multiples of 5, but (iv) very few negative values. In our dataset, no obvious distortions, except too many multiples of 0.5 %, are observed. Therefore, we estimate a simplified version of the model by Kamada *et al.* (2015).

3.3 Changes in distribution of inflation expectations

Figure 5 illustrates changes in estimated latent distribution of short-term inflation expectations. In the period of rising inflation (2004−2008) and after the Great Recession (2008−2012), the center of the distribution changed significantly. In contrast, as shown in Figure 6, little change was observed in the center of the distribution of the medium- to long-term inflation expectations, although the dispersion changed to some extent. This indicates that the medium- to long-term expectations tend to be more stable than short-term expectations and there appears to be a factor that affects only the short-term expectations.

As shown in Figure 5(3), a significant difference is noted before and after the introduction of QQE. First of all, distinctive shifts toward inflation are observed in the distributions of both the short-term and medium- to long-term inflation expectations. In particular, the center of the distribution of medium- to long-term inflation expectations clearly shifts only during this period. Moreover, as the distribution shifted toward inflation, the dispersion of both the short-term and medium- to long-term expectations increased from 2012 to 2014 and subsequently decreased from 2014 to 2016.

This change in the shape of the distribution can also be verified by examining the changes in descriptive statistics. Figure 7 provides three distinctive features. First, after the introduction on QQE, the mean values of both the short-term and medium- to long-term inflation expectations significantly increased. Second, variance also increased just after the introduction of QQE; however, it decreased after 2015. Third, skewness of medium- to long-term inflation expectations turned significantly positive in 2015 and then declined in 2016. In summary, it can be statistically verified that the distribution of inflation expectations shifted toward inflation after the introduction of QQE, whereas the dispersion increased from 2012 to 2014 and decreased subsequently.

These results indicate heterogeneity in expectation formation when expectations are revised in response to monetary policy shocks. Here, we examine how firms' inflation expectations vary according to their corporate attributes. We then find that firm size significantly affects differences in the inflation expectations after the introduction of

QQE[11]. As shown in Figure 8, larger firms tend to show a greater increase in inflation expectations after the introduction of QQE[12]. This characteristic is strikingly more prominent in medium- to long-term expectations than in short-term expectations. Moreover, the difference between expectations in large-sized firms and those in small-sized firms narrowed after reaching a peak in 2014. In particular, the difference in short-term expectations almost disappeared. Thus, it is implied that differences in firm size affect the variations in inflation expectations.

These observations can be confirmed by the "heat map" in Figure 9, where the inflation expectation level is indicated in color, with the vertical axis representing firms' capital stock. It indicates that larger-sized firms' short-term inflation expectations increased more after the introduction of QQE, although the timing of rising inflation expectations is almost identical across all the firms. These differences in the inflation expectation level have almost disappeared in 2016. In contrast, large-sized firms' medium- to long-term inflation expectations increased more at an earlier stage as compared with small-sized firms. However, from 2014 to 2016, medium- to long-term inflation expectations rose even among small-sized firms; thus, it can be observed that the number of firms expecting higher inflation is steadily increasing.

These results are consistent with Sims' rational inattention hypothesis (2003, 2006). In particular, when predicting future inflation rates, each firm's costs involved in obtaining relevant information and benefits gained by increasing prediction accuracy differ. This may cause the heterogeneous reaction of inflation expectations in response to monetary

[11] Although we also examined the relationship between inflation expectations and other business attributes, such as sector, overseas production ratio, and exchange rates forecast, no clear difference was observed among them either before or after the introduction of QQE.

[12] The result of the *Tankan* survey of inflation expectations after the introduction of QQE differs from that of the ASCB; in *Tankan*, the smaller firms have higher inflation expectations, which could be caused by a difference in the definition of "price index"; thus, inflation expectations in *Tankan* correspond to the CPI, whereas those in the ASCB correspond to the GDP deflator. As mentioned in footnote 6, the GDP deflator includes factors other than consumption. These factors could influence the difference between *Tankan* and the ASCB. Therefore, studying how differences in the definition of price index affect the level of or fluctuations in inflation expectations by waiting for the accumulation of comparable data is advisable.

policy shocks. For large-sized firms, the cost of information acquisition is thought to constitute only a very small portion of the overall cost. Furthermore, stronger correlation may exist between macroeconomic variables, including inflation expectations and the business environments for large-sized firms. Therefore, it is possible that the large-sized firms allot more resources to macroeconomic data collection, such as information released by the central bank, which then enables them to react to monetary policy shocks faster.

Coibion *et al*. (2015), who conducted survey research on corporate managers' inflation expectations in New Zealand, also support this result. They indicate that the heterogeneity of firms' inflation expectations might reflect a disparity in motivation to collect data on the macroeconomic environment due to differences in business structure. Differences in business structure among Japanese firms may also similarly affect the speed with which they update their inflation expectations.

4. Inflation Expectations and Wage-setting Behaviors

This section focuses on the relationship between inflation expectations and wage-setting behaviors. For the sustainable growth of the economy under positive-trend inflation, wages and prices have to increase in a balanced manner. Therefore, as Bernanke (2007) pointed out, the issue of which types of inflation expectations, short-term or medium- to long-term, have a greater role in wage- and price-setting behaviors is crucial. In particular, it is practically important for the Bank of Japan, which strives to achieve a price stability target of two percent, to analyze the dynamic relationship between wages and inflation expectations.

Therefore, in this section, we conduct our analysis in the following two steps. First, we examine the determinants of inflation expectations for both the short-term and the medium- to long-term expectations. Second, we conduct an empirical analysis via PVAR to evaluate the dynamic relationship between short- and medium- to long-term inflation expectations and wage-setting behaviors.

4.1 Determinants of short-term and medium- to long-term inflation expectations

Many previous studies about the determinants of inflation expectations indicate that purchasing costs influence short-term inflation expectations. For instance, Leduc *et al*. (2007) report that crude oil prices influence short-term inflation expectations. In contrast, many studies also report that the trend growth rate of inflation significantly influences medium- to long-term inflation expectations (e.g., Cecchetti, 2007).

This section focuses on the influence of purchasing prices. ASCB collects data on one-year forecasts of purchasing prices and exchange rates. In this survey, the firms respond with class values; thus, we considered the midpoint of each range (example: 15% for a "10% to 20%" response) as the explanatory variable. Furthermore, to reduce the influence of outliers, we winsorize 0.5% of the data at both ends of the distribution for every variable[13]. The estimation method used is Arellano and Bond's (1991) two-step generalized method of moments (GMM) estimation. The short-term and medium- to long-term inflation expectations are the dependent variables, while the contemporaneous/first lag of purchasing-price forecast rate, exchange rate forecasts, actual inflation rate (GDP deflator), and the own first lag are the explanatory variables.

The estimation results are presented in Table 1. First, with regard to the own first lag, the coefficient for the medium- to long-term inflation expectations is approximately twice that of the short-term, thus indicating that the former are stickier at each individual firm. Second, although the influence of the exchange rate forecast is significant for both the short-term and the medium- to long-term inflation expectations, it appears to influence short-term expectations more as the first lag is also more significant[14]. In contrast, the purchasing-price forecast rate has a significant positive influence on short-term inflation expectations only. This indicates that short-term inflation expectations might be more sensitive to the influence of cost factors, such as

[13] "Winsorizing" is a statistical method suggested by Hastings *et al.* (1947); for example, all data below the 0.5th percentile are replaced by the value of the 0.5th percentile while data above the 99.5th percentile are replaced by the value of the 99.5th percentile. In recent times, this method has often been used to analyze corporate financial data.

[14] The fact that one-year forecasts of exchange rates affect long-term inflation rates could reflect that the actual exchange rate fluctuated under a trend that continue for several years.

increases in material costs, other than exchange rates, compared with medium- to long-term inflation expectations. The results of this analysis are also consistent with previous studies, thus suggesting that commodity prices strongly influence short-term inflation expectations.

The finding that different factors are responsible for fluctuations in inflation expectations between the short-term and the medium- to long-term expectations indicates that both inflation expectations may affect wages differently. For instance, if an exogenous increase in purchasing cost, such as oil prices, causes an increase in inflation expectations, then the decrease in productivity with accompanying cost increases may negatively affect wages. In contrast, if rising inflation expectations reflect a sustained increase in the inflation rate, then it is possible that wages increase with prices through wage indexation. In the next section, we analyze the dynamic relationship between short-term and medium- to long-term inflation expectations and wage-setting behaviors.

4.2 PVAR estimation

In this section, we estimate PVAR to analyze the dynamic relationship between firms' inflation expectations and wage-setting behaviors. Generally speaking, Vector Auto Regression (VAR) estimation is difficult for short time series data because it has a limited degree of freedom. In contrast, PVAR allows us to analyze Granger causalities and impulse responses even with a short time series data by exploiting information regarding heterogeneity among individual firms in panel data[15].

VAR and PVAR are useful tools when investigating a dynamic relationship among variables, especially when causal relationships cannot be theoretically identified *a priori*. Clark and Davig (2008) estimate a VAR that incorporates actual inflation rate, short-term and medium- to long-term inflation expectations, economic activity index, and policy interest rates. They indicate that (1) short-term and medium- to long-term inflation expectations influence actual inflation and (2) actual inflation and economic activity influence short-term and medium- to long-term inflation expectations to some extent, although this influence is lesser on the medium- to long-term expectations, which are

[15] Canova and Ciccarelli (2013) provide an inclusive survey of the PVAR.

considered to be relatively anchored.

In this section, considering the simple nominal wage function that nominal wages are determined by inflation expectations and labor productivity, we estimate a PVAR that incorporates four variables: per-capita nominal wages, medium- to long-term inflation expectations, short-term inflation expectations, and ratios of operating profit to sales. Parameter estimation and selection criteria for lag order are based on the algorithm developed by Arigo and Love (2015). To obtain stationarity, we consider the first difference of the ratio of operating profit to sales and growth rates of all other variables. The estimation period is from 2004 to 2015[16].

A detailed explanation of the data is as follows. The ratios of operating profit to sales and per capita nominal wage data are individual firms' data based on the unconsolidated financial data recorded in the Development Bank of Japan's Industrial Financial Data. The ratios of operating profit to sales are computed by dividing operating profit by total sales. As in the two-step GMM estimation in Section 4.1, winsorizing is applied to the outlying 0.5% of the data at both ends of the distribution for each year on the ratios of operating profit to sales and on per capita nominal wages. Note that, here, per capita nominal wages cover only a part of publicly listed firms. Figure 10 illustrates that the individual firms' wages from corporate financial statements are almost identical to the monthly cash earnings (at a scale of 30 people or more) in the "Monthly Labour Survey" provided by the Ministry of Health, Labour and Welfare. It follows that the per capita nominal wages of publicly listed firms represent the macroeconomic development of wages to some extent.

In what follows, we examine the Granger causalities and impulse responses to shocks to inflation expectations. The order of variables in the Cholesky decomposition is as follows: medium- to long-term inflation expectations; short-term inflation expectations; the ratios of operating profit to sales; and per capita nominal wages.

[16] The ratios of operating profit to sales and per capita nominal wages correspond to the ASCB dataset on a fiscal year basis; for example, wages in fiscal 2012 correspond to the January 2013 survey of the ASCB.

4.3 Results of PVAR estimation

First, the Granger causalities between variables in Figure 11 indicate that a rise in short-term inflation expectations *per se* leads to a decrease in wages and operating profits. This relationship can be interpreted as follows. Note that purchasing costs tend to influence short-term inflation expectations. Thus, the situation in which only short-term inflation expectations rise without an accompanying rise in medium-to long-term inflation expectations is likely to represent the case in which firms cannot pass rising purchasing costs, such as oil prices, on to sales prices. The estimation results indicate that in such a situation, wages tend to be lower due to reduced profit margins.

The Granger causalities also indicate that a rise in medium- to long-term inflation expectations leads to an increase in both wages and short-term inflation expectations, thus implying that firms establish wages for their employees by considering the balance between price and wages in the long run. Moreover, the finding that medium- to long-term inflation expectations positively influence short-term inflation expectations indicates the importance of discerning the causes of change in short-term inflation expectations. In other words, we need to identify the cause of rising short-term inflation expectations to judge whether a rise in those expectations leads to an increase in wages.

Figure 12 illustrates impulse responses of wages to short-term and medium- to long-term inflation expectation shocks. As the data used in the estimation is year-on-year difference of growth rate, the accumulated impulse responses correspond to the year-on-year growth rate. The results of the estimation indicate that an increase in short-term inflation expectations negatively affects wages, whereas a rise in medium- to long-term inflation expectations positively affects wages, regardless of the direct negative effect from short-term inflation expectations.

We can draw two implications from the above results. First, to achieve balanced economic growth between price and wages, medium- to long-term inflation expectations are necessary to increase across a wide range of firms. Second, we have to sufficiently focus on medium- to long-term inflation expectations for forecasting wages because the development of short-term inflation expectations does not necessarily affect wage dynamics. However, as argued in Section 2, data on medium- to long-term inflation

expectations are scarce compared with short-term inflation expectations. If we can only monitor short-term inflation expectations, then it is important to consider the background behind the development of those expectations. It is also vital to consider that the above estimation results describe average firm behavior from 2004 to 2016.

5. Concluding Remarks

This paper matches the business survey for inflation expectations and corporate financial data to analyze changes in firms' short-term and medium- to long-term inflation expectations and wage-setting behaviors. First, firms' inflation expectations were found to have been significantly increased both in the short-term and the medium- to long-term after the introduction of QQE. During this period, dispersions of distributions of inflation expectations increased temporarily and then shrank again. These changes vary across business attributes, such as firm size, thus implying that these differences in business attributes might cause the heterogeneous reaction of inflation expectations to monetary policy shocks. From 2014 to 2016, medium- to long-term inflation expectations at small-scale firms began to rise, thus contributing to a decrease in dispersions of inflation expectations.

Next, we investigated the relationship between short-term and medium- to long-term inflation expectations and firms' wage-setting behaviors. Short-term inflation expectations were found to be more likely to reflect changes in purchasing cost changes. The analyses regarding the dynamic relationship between short-term and medium- to long-term inflation expectations and wage-setting behaviors indicate the following two points. First, a rise in short-term inflation expectations *per se* tends to reduce wages and operating profit ratios. This can be interpreted as representing the situation in which firms cannot pass rising purchasing costs on to sales prices; therefore, wages tend to be lower due to reduced profit margins. Second, when medium- to long-term inflation expectations rise, wages and short-term inflation expectations tend to increase, thus suggesting that Japanese firms may have, so far, considered a balance between price and wages when they set their employees' wages.

This analysis implies that to achieve balanced economic growth between prices and

wages, a wide range of firms need to persistently expect price increases. It also implies that wages tend to decline when an increase in medium- to long-term inflation expectations is significantly smaller than that in short-term inflation expectations. Thus, it is important for policymakers to examine medium- to long-term inflation expectations as well as short-term ones.

Finally, the following point must be considered when interpreting the results of this study. The inflation expectations used in this study correspond to GDP deflators instead of the CPI, which is mainly used by many central banks, including the Bank of Japan. In general, GDP deflators and the CPI can be considered to coincide except potential bias stemming from the difference in calculation methods in the long run. Nevertheless, to obtain a more direct insight, it is necessary to conduct analyses using CPI-based inflation expectations. In 2013, the Bank of Japan's *Tankan* began collecting data regarding firms' inflation expectations on a CPI basis. Therefore, in future research, analyses based on CPI-based inflation expectations should be considered.

Appendix: Parametric Estimation of the Underlying Distribution

In this Appendix, we assume a normal inverse Gaussian (NIG) distribution following Kamada *et al*. (2015) to explain the estimation method for the underlying distribution of inflation expectations.

Four parameters, m, v, a and b define the density function of a NIG distribution as follows:

$$f(x|m,v,a,b) = \frac{va \cdot \exp\left(v\sqrt{a^2-b^2}\right)K\left(a\sqrt{v^2+(x-m)^2}\right)\exp\left(b(x-m)\right)}{\pi\sqrt{v^2+(x-m)^2}}, \quad (1)$$

where $K(\cdot)$ is a Bessel function of the third kind, which is defined as follows:

$$K(x) = \frac{1}{2}\int_0^{\infty} \exp\left\{-\frac{x}{2}\left(y+\frac{1}{y}\right)\right\}dy.$$

The descriptive statistics are also functions of the four parameters as follows:

$$\text{mean} = m + vb/c, \quad (c = \sqrt{a^2-b^2}) \quad (2a)$$

$$\text{variance} = va^2/c^3, \quad (2b)$$

$$\text{skewness} = 3b/a\sqrt{vc}, \quad (2c)$$

$$\text{kurtosis} = 3(1+4b^2/a^2)/vc. \quad (2d)$$

Denote firm i's inflation expectation at survey round t by x_{it} and the underlying distribution of inflation expectations by $f(x_{it}|\, m_t, v_t, a_t, b_t)$. Then, the distorted distribution of the firm's inflation expectations is given by $g(x_{it}\,|\, m_t, v_t, a_t, b_t, \rho_t)$ as follows:

$$g(x_{it}\,|\, m_t, v_t, a_t, b_t, \rho_t) =$$

$$\begin{cases} f(x_{it}) + \rho_t \int_{j-0.25}^{j+0.25} f(s)ds & \text{for } x_{it} = j \quad (3a) \\ (1-\rho_t)f(x_{it}) & \text{for } j-0.25 < x_{it} \le j+0.25 \text{ and } x_{it} \ne j, \quad (3b) \end{cases}$$

where j denotes the numbers in multiples of 0.5 percent in $-4.5 \le j \le 4.5$. x_{it} over ±4.5 percent are excluded as outliers. The maximum likelihood method is used to estimate the parameters. We define a likelihood function for each survey round. The likelihood function at time t is given by $L_t = \prod_i g(x_{it}\,|\, m_t, v_t, a_t, b_t, \rho_t)$.

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Table 1. Estimation Result of Dynamic Panel Analysis

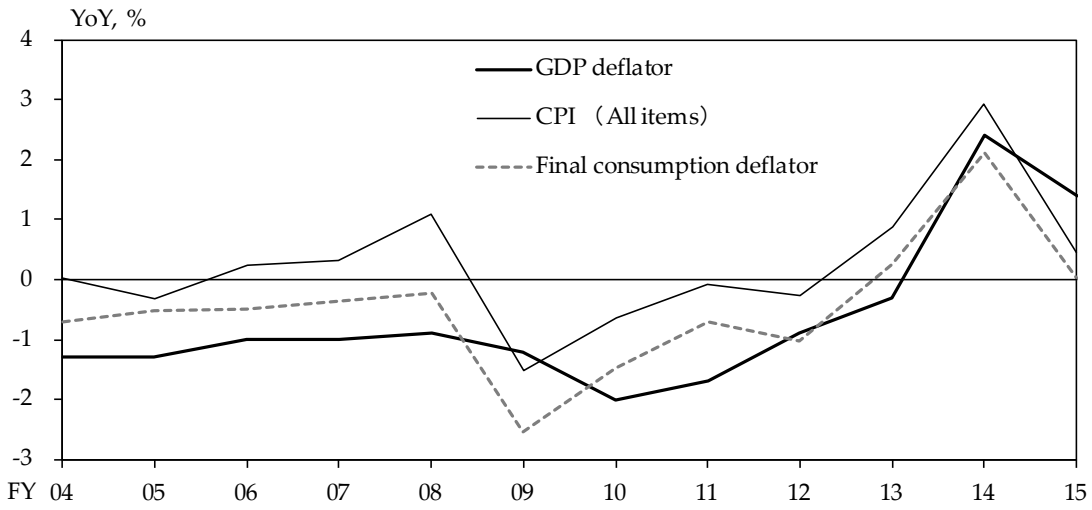
	Medium- to long-term inflation expectations		Short-term inflation expectations	
	Coefficient	Standard error	Coefficient	Standard error
Medium- to long-term inflation expectations				
First lag	0.169 ***	0.040		
Short-term inflation expectations				
First lag			0.088 **	0.042
Forecast rate of changes in average purchase price				
The contemporaneous value	0.001	0.004	0.010 **	0.005
First lag	0.002	0.003	0.011 **	0.005
Forecast of foreign exchange rate (yen-dollar rate, year-on-year change)				
The contemporaneous value	0.005 **	0.002	0.007 ***	0.002
First lag	-0.002	0.002	0.005 **	0.002
GDP deflator				
The contemporaneous value	0.035	0.027	0.037	0.033
First lag	0.114 ***	0.019	0.093 ***	0.023
Constant	0.001 ***	0.000	-0.001 ***	0.000
Arellano-Bond test First order	-7.90 ***		-7.53 ***	
Arellano-Bond test Second order	-0.31		0.05	
Observations	1,852		1,935	
Number of firms	547		564	

Notes: 1. Estimation conducted using the two-step Arellano-Bond GMM estimator. As for the standard errors, we use the robust estimator based on Windmeijer (2005).

2. The estimation period is from 2004 to 2015. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

3. "Forecast rate of changes in average purchasing price" and "Forecast of foreign exchange rate (yen-dollar rate, year-on-year change)" are the averages of the class values.

Figure 1. CPI and GDP Deflator



Sources: Cabinet Office; Ministry of Internal Affairs and Communications.

Figure 2. Inflation Expectations from the Annual Survey of Corporate Behaviors

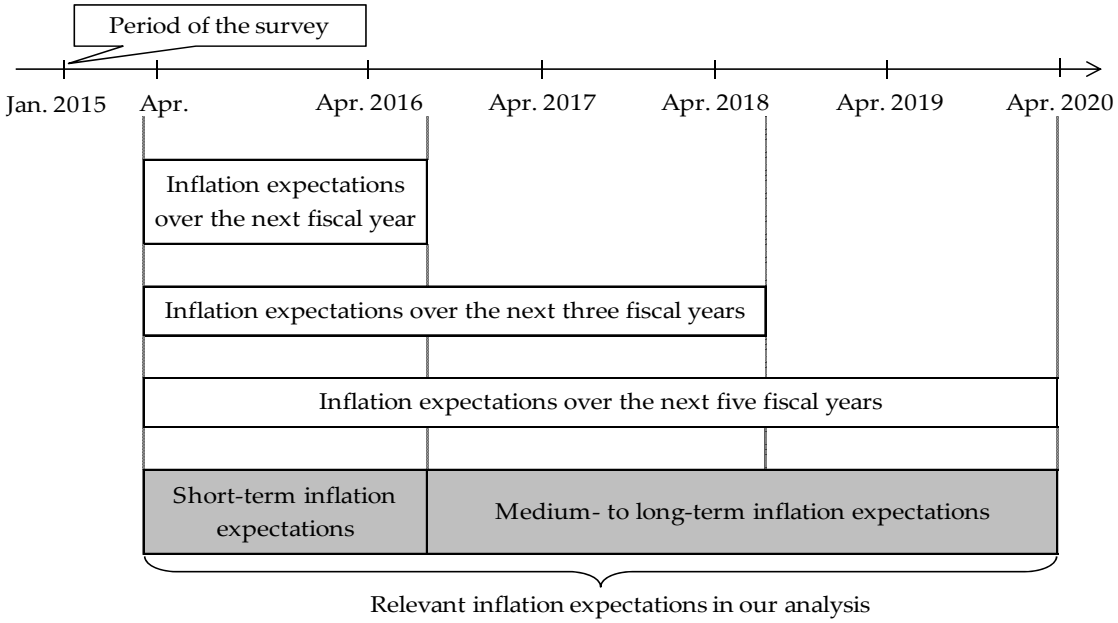
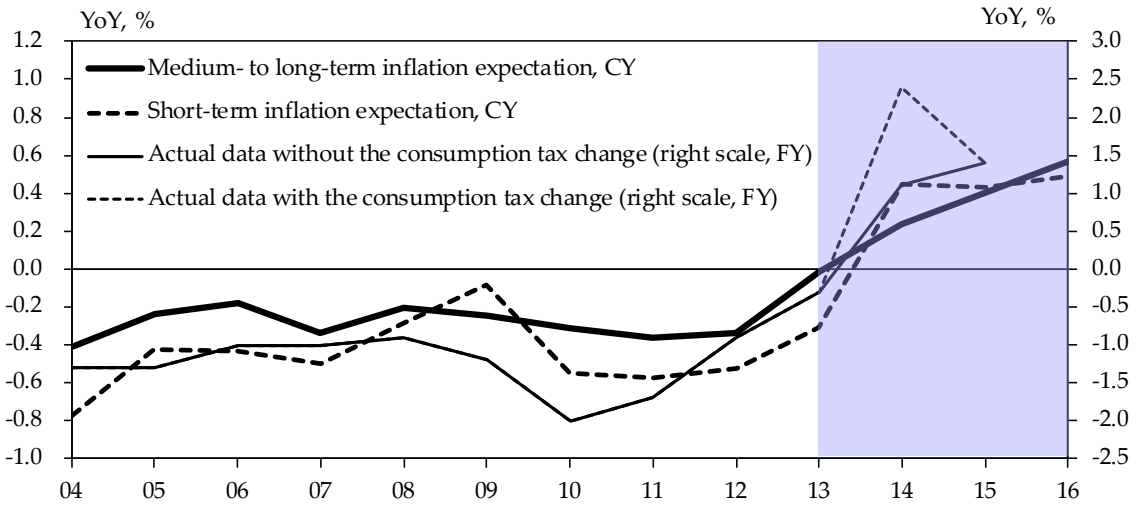
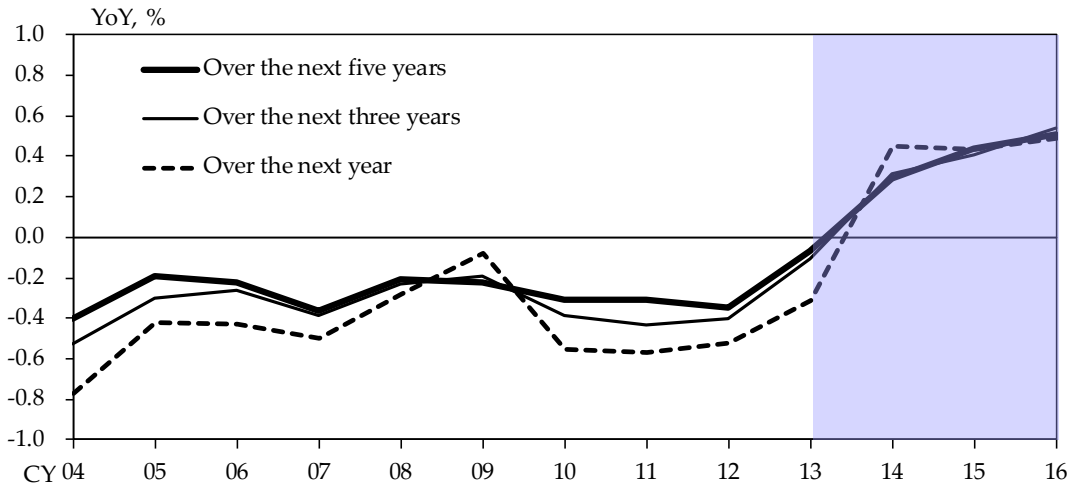


Figure 3. Mean Response of Inflation Expectations

(1) Short-term/Medium- to long-term inflation expectations



(2) Inflation expectations over the next year/the next three years/the next five years

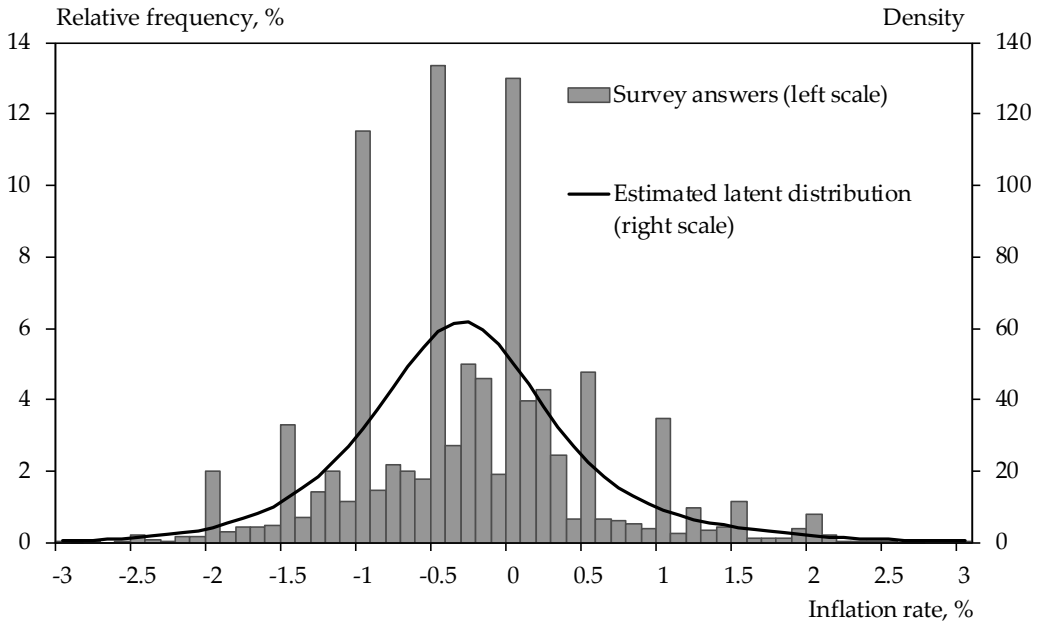


Notes: 1. The shaded areas indicate the period after the introduction of QQE.

2. "Actual data with the consumption tax change" are calculated by the Cabinet Office.

Source: Cabinet Office.

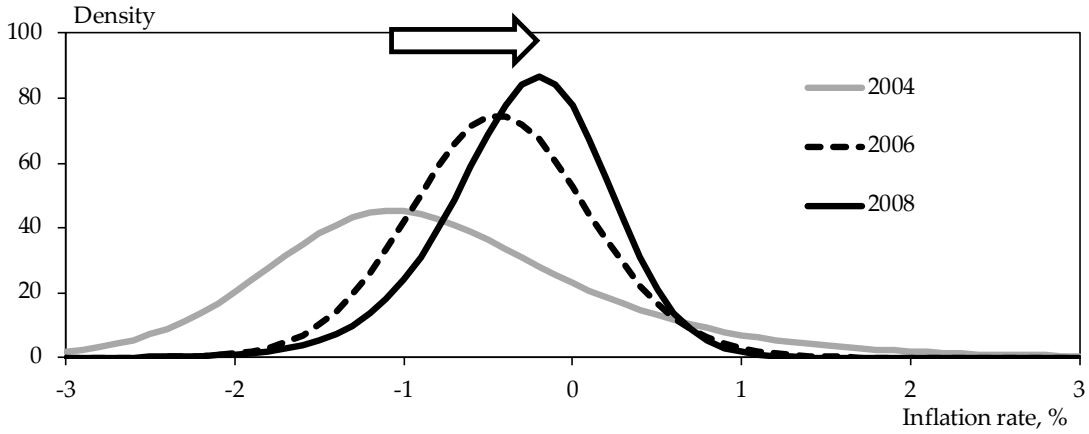
Figure 4. Distribution of Short-term Inflation Expectations



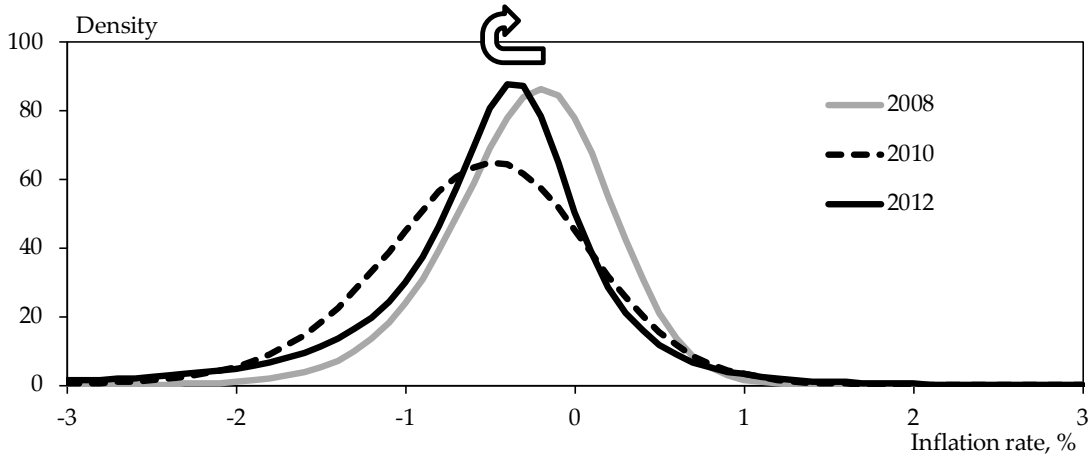
Note: Pooled data between 2004 and 2016.

Figure 5. Distributional Shift of Short-term Inflation Expectations

(1)Periods of rising inflation



(2)Periods after the global financial crisis



(3)Periods after the introduction of QQE

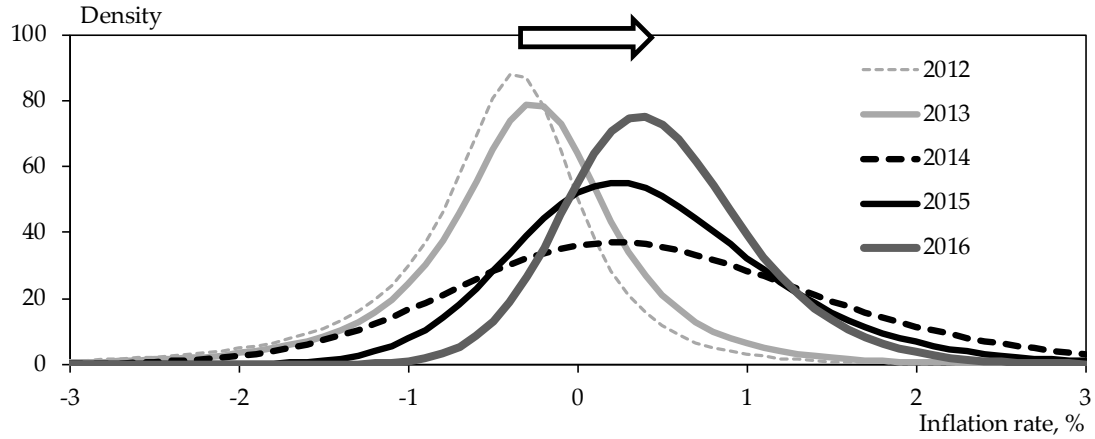
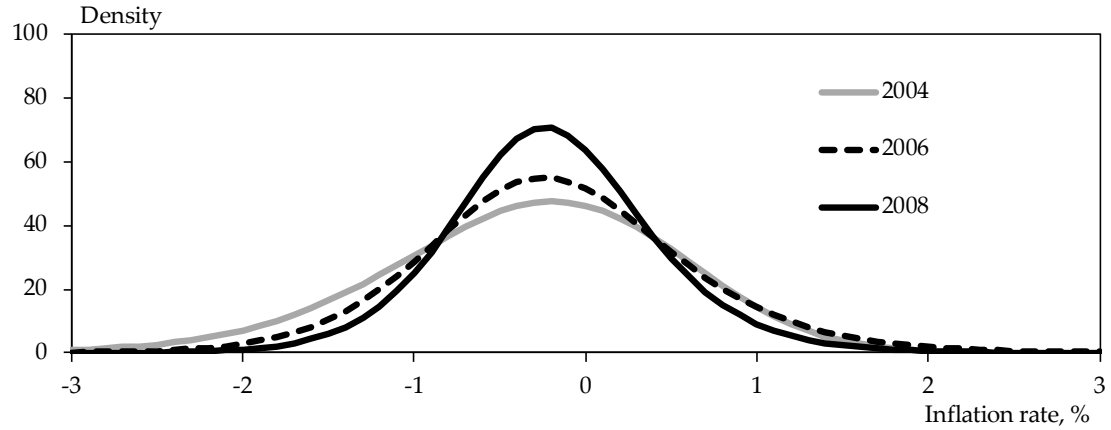
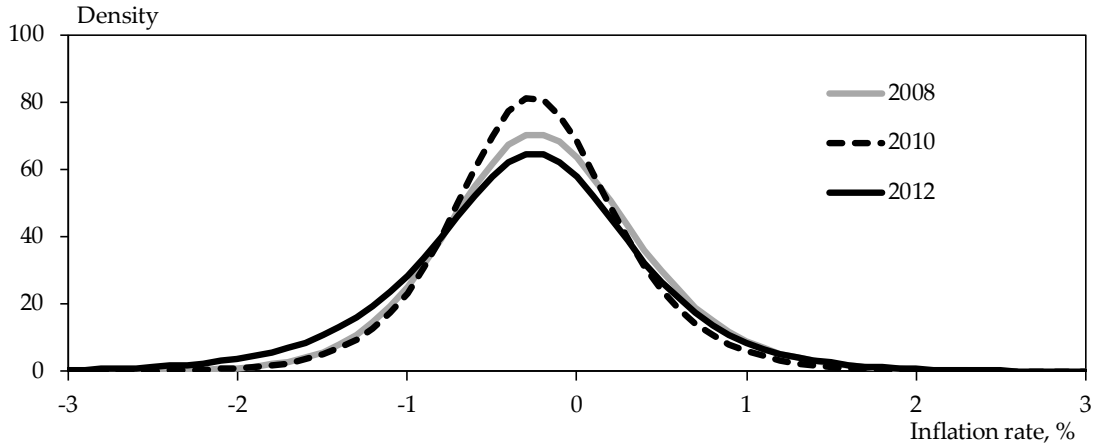


Figure 6. Distributional Shift of Medium- to Long-term Inflation Expectations

(1)Periods of rising inflation



(2)Periods after the global financial crisis



(3)Periods after the introduction of QQE

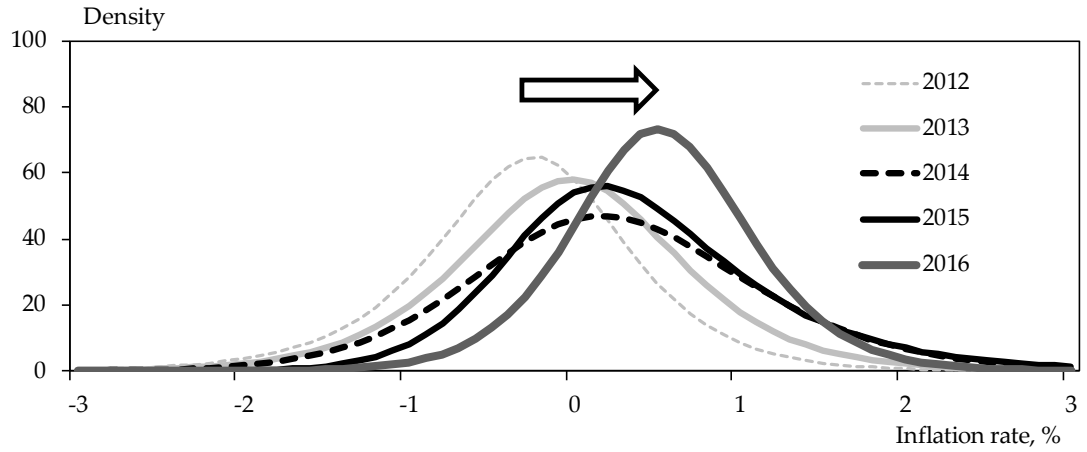
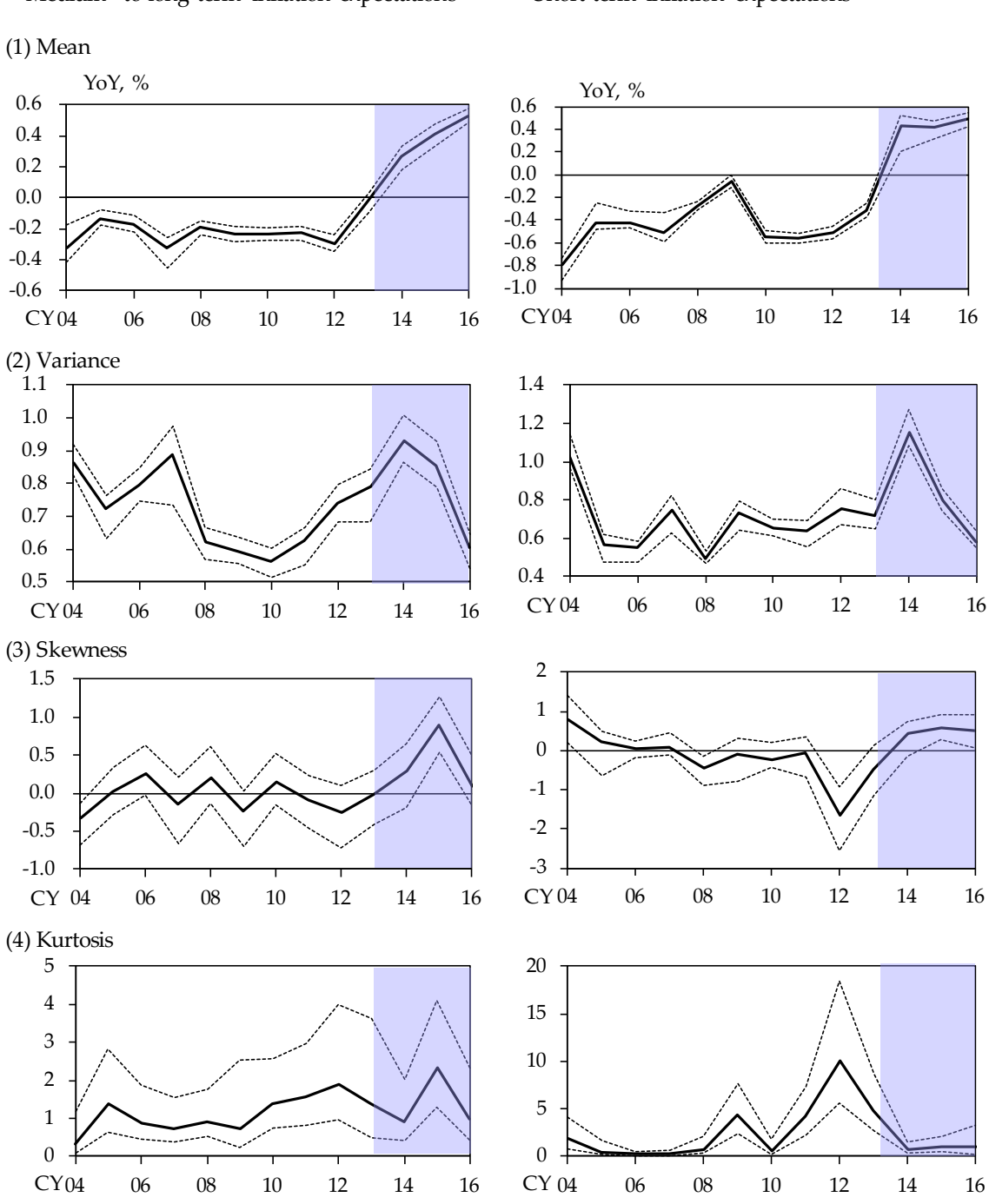


Figure 7. Descriptive Statistics of Underlying Distribution of Inflation Expectations

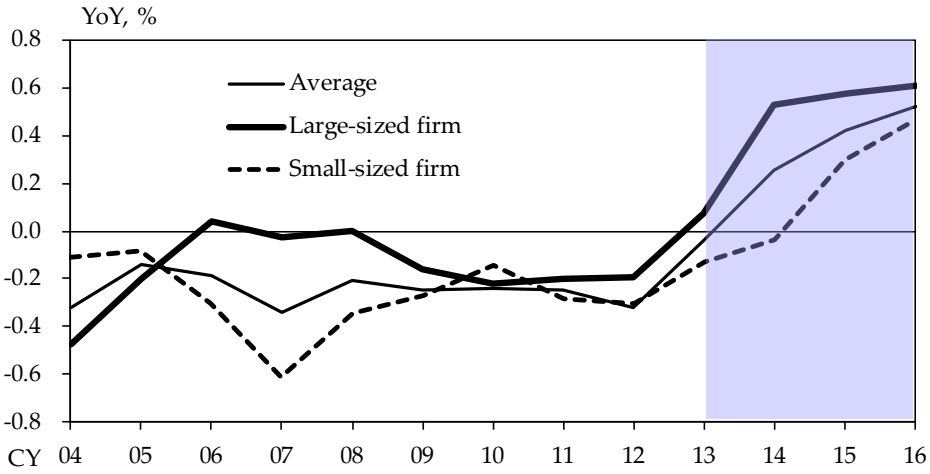


Notes: 1. The shaded areas denote the period after the introduction of QQE.

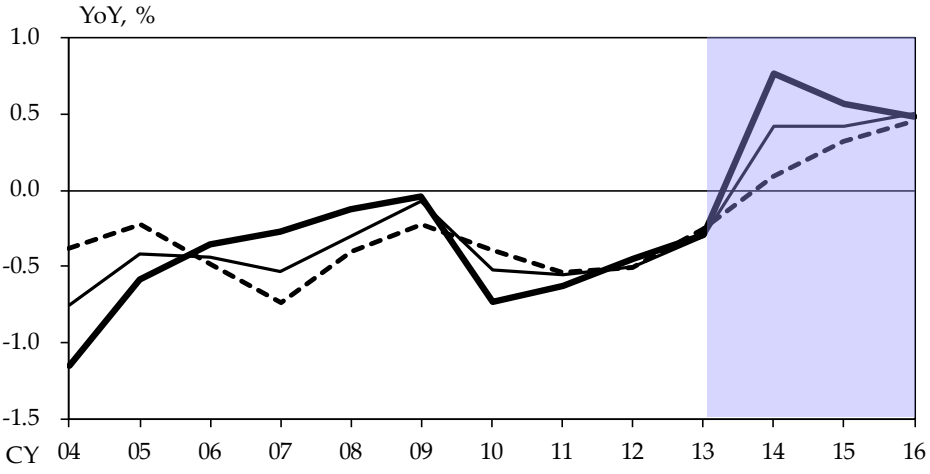
2. Dotted lines indicate 95 % confidence intervals.

Figure 8. Inflation Expectations by Firm Size

<Medium- to long-term inflation expectations>



<Short-term inflation expectations>



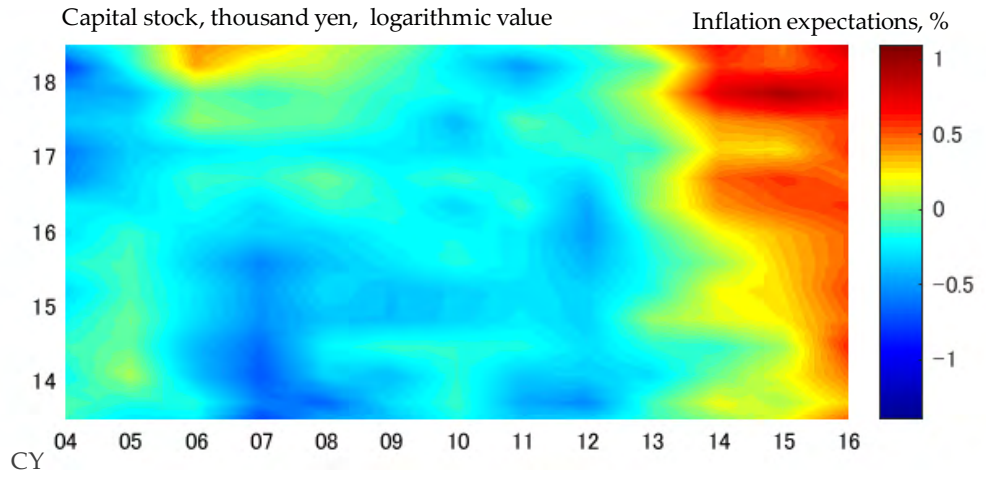
Notes: 1. Large-sized firms cover the top 25% of the firms ranked by capital stock while small-sized firms cover the lowest 25%.

2. We assume that the capital stocks in 2016 are the same as those in 2015.

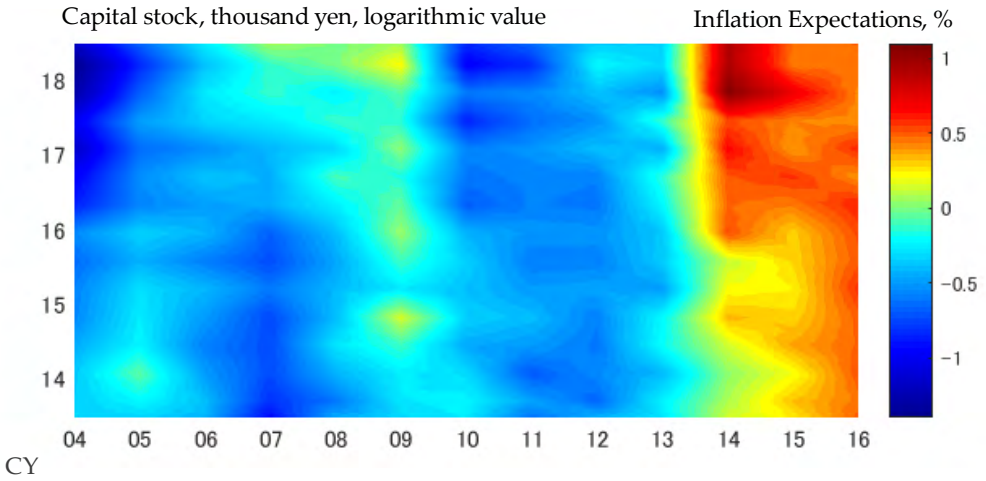
3. The shaded areas denote the period after the introduction of QQE.

Figure 9. Heat Map for Inflation Expectations by Firm Size

<Medium- to long-term inflation expectations>

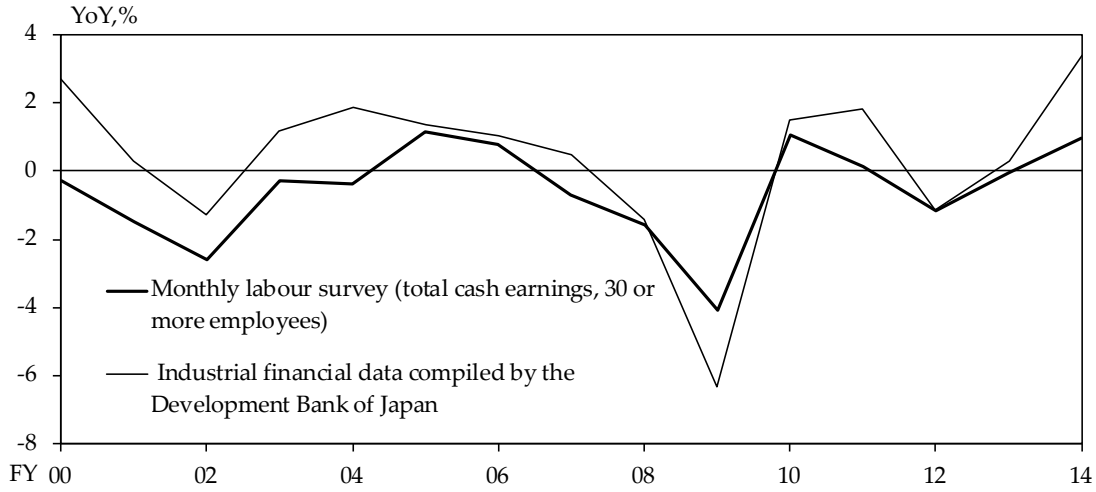


<Short-term inflation expectations>



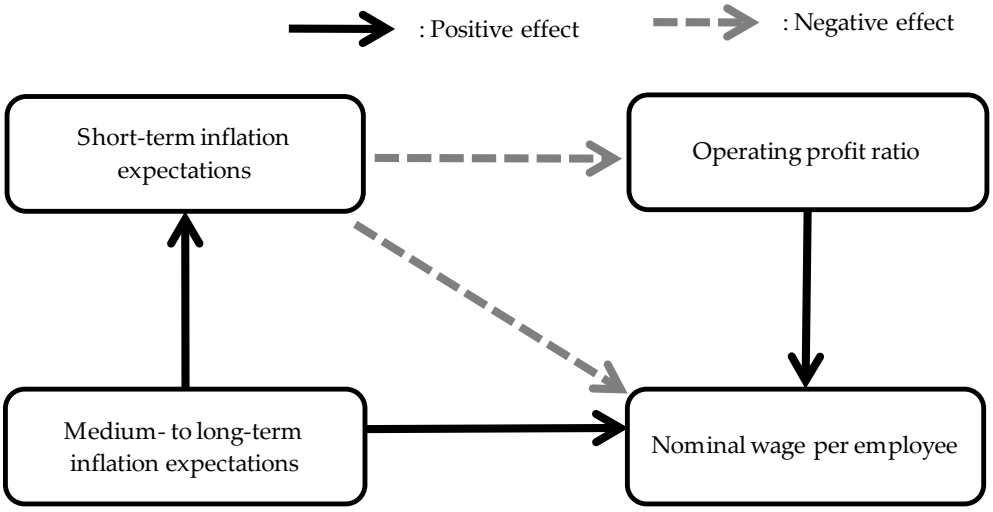
Note: We assume that the capital stocks in 2016 are the same as those in 2015.

Figure 10. Comparison of Wages between Macro Statistics and Corporate Financial Statements



Sources: Ministry of Health, Labour and Welfare; Development Bank of Japan.

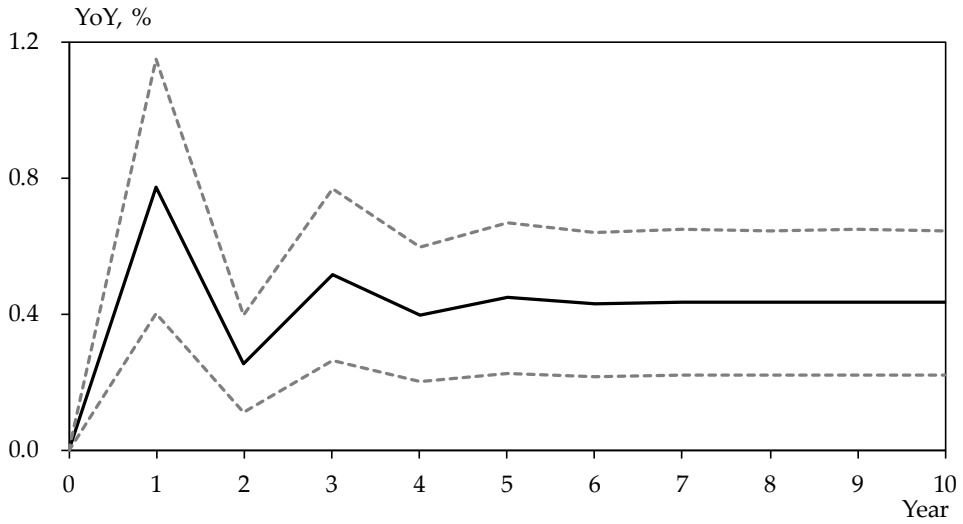
Figure 11. Granger Causalities



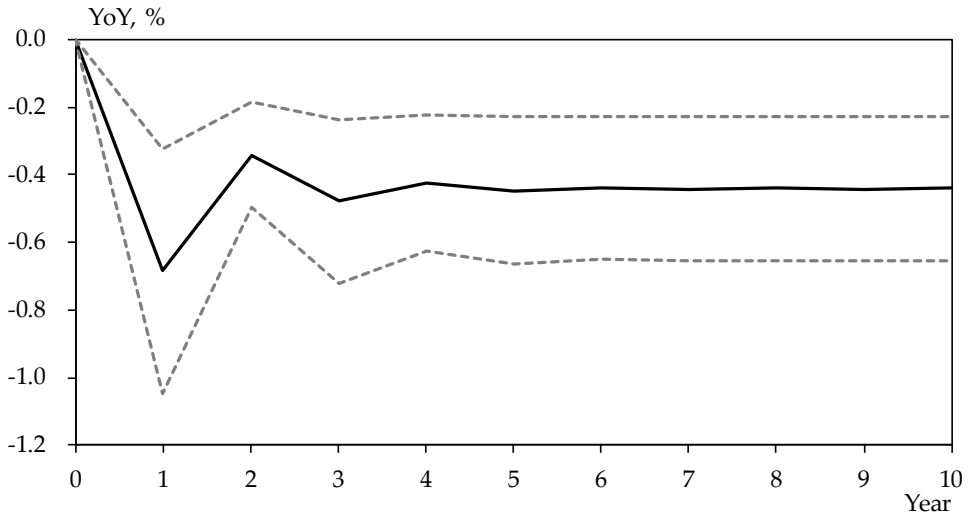
Note: The arrows indicate that the null hypothesis of no causality can be rejected at the 1% significance level.

Figure 12. Impulse Responses of Wages to Short-term and Medium- to Long-term Inflation Expectation Shocks

(1) Medium- to long-term inflation expectation shock ⇒ Wage



(2) Short-term inflation expectation shock ⇒ Wage



Note: The solid and dotted lines represent the PVAR model's impulse response and its 90% confidence interval, respectively.