The Impact of Regime Change on the Influence of the Central Bank's Inflation Forecasts: Evidence from Japan's Shift to Inflation Targeting*

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Many central banks release inflation forecasts to reduce uncertainty; at the same time, an increasing number rely on a publicly stated medium-term inflation target to help anchor expectations. We examine how the adoption of an inflation target (IT) by a major central bank, the Bank of Japan (BOJ), influenced the impact of its inflation forecasts on private-sector expectations. We find that the relative accuracy of central bank forecasts versus those of the private sector declined, a deterioration not evident in GDP forecasts. This appears to have been due to a structural (upward) shift in central bank inflation forecasts with the introduction of the IT regime. Regression results suggest that private-sector forecasts discounted the shift in central bank forecasts. The results are consistent with a regime, after the adoption of inflation targeting, in which the

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private sector viewed the central bank forecasts as upwardly biased. More generally, they confirm the difficulty in raising inflation expectations from below in the presence of an effective lower bound in the nominal policy interest rate.

JEL Codes: E31, E52, E58.

1. Introduction

How central banks should best communicate to the market is an increasingly important topic in the central banking literature. With ever greater frequency, central banks communicate through forecasts of prices and output over both the near and medium term. These forecasts can serve the purpose of reducing errors and uncertainty by private forecasters, with regard to economic fundamentals as well as the future policy actions of the central bank. In so doing, they can improve the effectiveness of other central bank communications and policies as well as economic welfare more generally. This paper contributes to the literature on central bank forecasts, by documenting how the release of the forecasts of one major central bank—the Bank of Japan (BOJ)—has been influencing private-sector expectations of inflation, and asking why the nature of this influence may have shifted over time.

At the same time, central banks of the 21st century generally rely on a publicly stated medium-term inflation target to help anchor expectations of inflation. Inflation targeting (IT) removes uncertainty about at least one of the ultimate objectives of the central bank, however much macroeconomic and global shocks may influence near-term inflation outcomes. The Bank of Japan adopted inflation targeting in early 2013, relatively late in the community of central banks in advanced economies, and more than a decade after they began to release economic forecasts. This paper aims to examine whether the impact of Bank of Japan forecasts on those of the private sector has been influenced by the adoption of an inflation target, which makes this paper unique in the empirical literature.

In contrast to most other advanced economies' experiences with inflation targeting, where IT was introduced in an effort to bring overly high inflation down and stabilize it at low levels, the Bank of Japan moved to IT when existing inflation (and indeed the inflation

of the previous 15 years) was below the new target. In cross-country work, Ehrmann (2015) suggests that central banks may have more difficulty in hitting newly adopted inflation targets from below than from above, as inflation expectations in such cases can be sticky in response to positive inflation surprises. The data set of Ehrmann's paper ends too quickly to lend insight into Japan's experience, however.

The value-added of our paper is as follows. While there is a large literature on the effectiveness of inflation forecasts, as well a separate one on the effectiveness of IT frameworks for monetary policy, our paper is the first, to our knowledge, that empirically examines how inflation forecasts by the central bank might be affected by the introduction of an inflation-targeting regime. The main theoretical reference to date is Dale, Orphanides, and Osterholm (2011), which models the joint presence of private-sector and central bank inflation forecasts, as well as of central bank inflation targets. In the model, if central bank forecasts are imprecise enough, the introduction of inflation targets can crowd out a role for central bank forecasts in communicating imperfect information. Changes to other parameters of the model can do so as well, such as a structural change that makes it difficult for the private sector to assess the quality of the central bank's forecasts.

Another argument is that central bank (CB) forecasts may be discounted in an IT regime, because the CB has the incentive to adjust its forecasts towards the target to communicate its commitment to achieve the inflation target. In other words, with a target to meet, central bank inflation forecasts became more Odyssean in nature rather than Delphic (for discussions of the distinction, see Campbell et al. 2012 and Andrade et al. 2018).[1] Because private forecasters are ex ante aware of the dual nature of the central bank's forecast once there is an inflation target, they will discount the central bank forecasts relative to those undertaken before the target was adopted, if the bank's ability to achieve it is in doubt.

[1]In fact, from April 2013, shortly after the adoption of inflation targeting, it was announced that BOJ inflation forecasts would be made assuming the effects of past policy decisions. Since that time, at least during the sample period of this paper, its two-year-ahead inflation forecasts (excluding consumption tax effects) had been close to around 2 percent. Prior to that time, forecasts had been only conditioned on the future path of interest rates (see footnote 15).

Japan introduced an inflation target when its inflation was below the target, which is not the typical situation in which inflation targeting has been introduced historically. But below-target inflation can no longer be viewed as unusual, with inflation levels in advanced as well as many emerging economies persistently weak and well below established targets. For countries that may be considering introducing an inflation-targeting regime in the midst of a secular wave of disinflationary pressure, the experience of Japan poses important lessons. The Japanese experience also allows us to investigate whether the influences of the IT regime that might in theory affect the accuracy of inflation forecasts have in fact been observed in practice.

Historically speaking, Japan introduced an inflation target due to a political shock, which had been largely unpredicted at the time. The introduction of inflation targeting was triggered by the election of the Liberal Democratic Party (LDP) and its leader Shinzo Abe to prime minister in December 2012. Aggressive monetary policy easing was one of his "three arrows" of economic policy, and once he became prime minister, Abe insisted on an inflation-targeting regime to achieve this end. While the nomination and ascension of Haruhiko Kuroda to be governor of the Bank of Japan in April 2013 is often associated with inflation targeting in Japan, it was because of the Abe administration's pressure that Governor Shirakawa was forced to introduce an inflation-targeting regime in January 2013 well before his term ended.[2]

Abe's victory in the election of the LDP leadership the previous September was not widely expected, and in fact the result was quite a close call. Were it not for a last-second endorsement, the head of the party and the eventual position of prime minister could easily have gone to an individual with much more conservative views on monetary policy.[3] Thus, when considering the political events

[2]On November 12, 2012, Shirakawa stated in a public speech the view that it was economic growth supported by increased growth potential that was necessary to overcome deflation (Shirakawa 2012). Moreover, in his memoirs Shirakawa wrote, "I was against strongly adhering to a specific number like '2%' for the target inflation rate (authors' translation)" (Shirakawa 2018, p. 318).

[3]There were in fact five candidates up for the LDP's presidential election in September 2012. A veteran politician, Shigeru Ishiba, won considerably more votes than Abe in the first round of voting—199 votes versus 141 (out of 489).

as they actually occurred, Japan would appear to provide a natural experiment on what would happen to central banks' and the private sector's inflation forecasts after an unanticipated political shock results in the introduction of an inflation-targeting regime.

To preview our results, in the estimations that follow, we find that after the introduction of inflation targeting, the relative accuracy of central bank forecasts versus those of the private sector declined. Such a relative deterioration of central bank forecast performance is not evident in the gross domestic product (GDP) forecasts. This appears to be due to a structural shift in central banks' forecasts starting with the introduction of the IT regime. Regression estimates of monthly changes in private-sector forecasts, which include the deviation of their forecasts from Bank of Japan forecasts as an explanatory variable, then show the best fit to be one that includes a level shift downward in the IT era, which discounts the change in BOJ forecasts. Once again, a similar pattern is not apparent in the case of regressions for GDP forecasts.

The adjustment of central bank forecasts does not appear due to their being crowded out by perfectly credible inflation targets, nor do the regression results suggest that increased uncertainty with regard to the precision of central bank forecasts are the main factor, as theory might suggest (Dale, Orphanides, and Osterholm 2011). Rather, the results are consistent with central bank forecasts having become more Odyssean (Campbell et al. 2012 and Andrade et al. 2018), and private-sector forecasters largely adjust for the resulting bias of the central bank forecast, anticipating the problems of monetary transmission in an era of chronically below-target inflation and the zero lower bound.

Abe was not welcomed by a number of big names, including the head of his own political faction. Abe only became a viable candidate when Taro Aso, a former prime minister, decided to support Abe at the last moment. Because the top candidate did not get the majority of votes, it went to a second round, which is the first time that had happened in more than 40 years. In the second round, Abe won the majority. This in turn was the first time that the candidate in the second place in the first-round voting had won in the final round in more than 70 years. The previous front-runner, Ishiba, had expressed a reserved view about inflation targeting and aggressive monetary easing, expressing more concerns about the risk of high inflation by mentioning the possibility of hyperinflation in past interviews to media in 2010 (LDP Policy Research Council Chairperson's Regular Press Conference, February 17, 2010) and 2012 (*Nikkei* newspaper, December 21, 2012).

The rest of the paper will proceed as follows. In the next section, we review the literature on central bank forecasts as a form of central bank communication, as well as communication in light of the introduction of inflation-targeting regimes. In section 3, we discuss the data and institutional background, as well as outline the empirical strategy behind the tests for the effectiveness of central bank forecasts. Section 4 reviews the performance of central bank and private-sector forecasts both prior to and subsequent to the introduction of inflation targeting, and tests for structural breaks in the forecast series. In section 5, we present the main results, based first on monthly, and then quarterly, data. Section 6 concludes.

2. Review of the Literature: The Impact of Central Bank Inflation Forecasts and Targets

The literature on the role of central bank communication in monetary policymaking exploded in the late 1990s and the early 2000s, and this early literature is summarized comprehensively in Blinder et al. (2008). To quote its assessment, central bank communication "has the ability to move financial markets, to improve the predictability of monetary policy, and the potential to help monetary authorities achieve macroeconomic objectives." At the same time, there was not yet a consensus on best practice across central banks, since communication strategies clearly differed significantly.

An increasingly important strand of the literature focuses on how central bank communication affects private-sector forecasts of inflation. Since private-sector expectations of inflation determine ex ante real interest rates, by influencing these expectations central bank communication can in turn determine monetary conditions. Romer and Romer (2000) show that the Federal Reserve had, at least during their period of investigation, superior information to the private sector when it came to inflation forecasts, and the private sector indirectly inferred this information from the policy changes undertaken by the Federal Reserve. A number of other papers have since shown that the release of information by the central bank can increase the predictive precision of private interest rate forecasts.

An early look at the influence of the publication of the central bank's own inflation forecasts in clarifying future economic developments was provided by Fujiwara (2005), who showed that central

bank forecasts have a significant effect on private-sector forecasts as well as diminishing uncertainty. The more recent strands of the literature document the impact of central bank forecasts on the actual level of private-sector inflation expectations. Hubert (2014) found that central bank forecasts in the case of the United States became a focal point for private-sector expectations, while Pedersen (2015) showed that the forecasts published by the central bank in the case of Chile influenced the short-run inflation forecasts of the private sector. Hubert's (2015) study of five advanced economies again found that central bank inflation forecasts indeed influence the level of private forecasts in all cases. More recently, de Mendonca and de Deus (2019) find that higher central bank forecasts in three emerging market economies result in upwardly revised private-sector forecasts, but more in the case of GDP growth than inflation forecasts.

Though also a subject of the central bank communication literature, the announcement of medium- to long-term inflation targets differs from those of inflation forecasts. The introduction of inflation targeting has been shown to reduce the dispersion of inflation forecasts generally (Crowe 2010), which is what theory would predict if targets are credible enough to provide an anchor to expectations. However, the finding does not apply when only developed countries alone are examined (Cecchetti and Hakkio 2009, Capistran and Ramos-Francia 2010).[4] Likely reasons for this finding include the pre-existing relative stability of inflation in developed countries and already homogenous views about future developments.

Inflation-targeting regimes became widespread in an era when countries viewed them as a tool to rein in high inflation by anchoring expectations at the target. However, over the past decade weak inflation has meant that inflation has been persistently below levels considered optimal across a wide range of countries, not least the United States. Ehrmann (2015) suggests that at low levels of inflation, inflationary expectations are less likely to be anchored

[4]The results are not yet clear-cut in cross-sectional empirical work either. While Ehrmann, Eijffinger, and Fratzscher (2012) find that transparency—in which having an inflation objective is one component—can reduce the dispersion of inflation forecasts, by contrast, Siklos (2013), in a study covering nine economies, finds that transparency of the central bank is associated with an increase in disagreement of inflation forecasts, a finding which holds regardless of IT regime.

by a target, and are more sensitive to lower-than-expected inflation shocks than higher-than-expected inflation shocks. The author concludes there may be unique difficulties in managing inflationary expectations when the central bank is targeting inflation from below, perhaps due to the difficulties of operating monetary policy at the effective zero lower bound.[5]

How might the impact of central bank inflation forecasts on private-sector expectations change with the adoption of an inflation target? Morris and Shin (2002) make the point that public information has potentially a dual role: it both conveys the status of fundamentals and serves as a focal point for beliefs. In the latter role, there are conditions under which it can crowd out the incentive of the private sector to produce high-quality forecasts.[6] Demertzis and Viegi (2008) apply the Morris-Shin model explicitly to the announcement of an inflation target and show that inflation targets may indeed serve as focal points for coordinating private expectations. But they note that anchoring is improved only if large shocks are not anticipated and all other public information is unclear.

As mentioned in the introduction, in the theoretical article by Dale, Orphanides, and Osterholm (2011), the private sector and the central bank both produce inflation forecasts, using their own forecasting models, and the central bank also has the ability to announce an inflation target. The private sector takes the central bank's forecast into account when forming its forecast: the private-sector forecast is the weighted average of forecasts solely based on its own model and one published by the central bank, and if the recent relative performance of the central bank forecast declines, the weight on

[5]Christensen and Spiegel (2019) also provide evidence that inflation targets are difficult to achieve from below.

[6]Morris, Shin, and Tong (2006) specified further the conditions under which the crowding out of the incentive to provide accurate forecasts might occur. Demertzis and Hoeberichts (2007) and Kool, Middeldorp, and Rosenkranz (2011) present related models in which increased transparency of central bank communication can also crowd out private information. An empirical study that relates an inflation target to the level impact of central bank inflation forecasts is Pedersen (2015). When private forecasters believe that inflation will be over the central bank's target in the medium and long term, the short-run inflation forecasts are then higher than otherwise. However, as an inflation target is in place throughout the sample period, the paper does not assess whether the existence of the target itself affects the influence of central bank forecasts.

the central bank forecast in forming the private-sector forecast will also decline accordingly. The information value of the central bank's forecast is effectively discounted.

As for interaction between inflation forecasts and targets in the paper's model, while inflation forecasts are of variable precision (as in Morris and Shin 2002) and thus have "the potential to mislead and distract," inflation targets, by contrast, are assumed to be credible and thus can make central bank forecasts redundant and less distracting to the private sector (see Dale, Orphanides, and Osterholm 2011, p. 24ff). Within the framework of the model, channels through which central bank inflation forecasts can lose explanatory power with the introduction of an inflation target include (i) the inflation target anchors expectations such that the noisy central bank forecast now adds less net information to the market; (ii) the introduction of the inflation target raises uncertainty about the central bank's model of the inflation and the precision of their forecasts.[7]

Though not covered by the model in Dale, Orphanides, and Osterholm (2011), there is a further explanation of why central bank inflation forecasts can lose explanatory power under inflation targeting: the forecasts may become more Odyssean in nature to communicate the central bank's intent to achieve the target (Campbell et al. 2012 and Andrade et al. 2018), while private-sector forecasters may be skeptical about the central banks' ability to achieve the adopted inflation target. This skepticism can become particularly ingrained when attempting to reach inflation targets from below, due to the effective zero lower bound of the nominal policy interest rate. In this case, even if the central bank's target has credibility of intent, the lack of credibility of action may further feed skepticism (See Bomfim and Rudebusch 2000 for further discussion of this distinction).

[7]The above summary is based both on the model setup in Dale, Orphanides, and Osterholm (2011) and footnote 11 in the same work. In footnote 11, the authors note that the gain parameter k^f which represents an ability to assess the quality of the central bank's forecasts, "could also be seen as partly reflecting the extent to which the central bank makes and communicates changes in its analytical framework." So while clarity of objectives of inflation targets may encourage more aggressive easing (Orphanides 2018), we interpret the model as implying that when accompanied by untested actions, the parameter reflecting the ability of the private sector to assess the quality of the central bank forecast could be affected by the change of monetary policy regime.

In sum, the literature, despite clarifying in many respects how central bank forecasts might affect private forecasts, still has open questions with regard to how that impact might be affected by the introduction of an inflation target. Further, the empirical forecasting literature suggests that the properties of central bank inflation forecasts under an inflation-targeting regime might differ from those without inflation targets, particularly when the central bank has difficulty targeting inflation from below. Our paper, by focusing on the case of Japan, in which the central bank has provided inflation forecasts since 2000 but only since 2013 introduced an inflation-targeting regime, is well placed to shed light on the issue.[8]

3. Data and Empirical Strategy

3.1 Data

3.1.1 Private-Sector Forecasts

The main objective of the empirical analysis is to assess the impact of the forecasts of the Bank of Japan on private-sector inflationary expectations. As the main proxy measure of private inflationary expectations, we take the inflation forecasts from the so-called ESP survey of professional forecasters surveyed by the Japan Center for Economic Research (JCER). The survey started in 2004, which thus determines the beginning of the sample period for our regression analysis (2004–16).[9] Around 40 economists and market analysts from the private sector and independent research institutes are asked

[8]There is also a literature that investigates how individual forecasters' incentives in the private sector can pose tradeoffs with the objective of minimizing forecast errors. For example, some forecasts are biased towards outcomes that favor the forecaster's employer (Ito 1990), while others can be influenced by the incentives of less able forecasters to mimic more capable ones (Ehrbeck and Waldmann 1996), or the incentives to benefit from the publicity that results from sharp differences from the consensus (Laster, Bennett, and Geoum 1999; Ottaviani and Sorensen 2006).

[9]The ESP forecasts were originally collected by the Economic Planning Association, an organization affiliated with the Cabinet Office, which published a periodic journal titled *Economy, Society, Policy* (which is where the acronym "ESP" came from). In April 2012, the Japan Center for Economic Research took over the survey.

their forecasts for the change in annual average level of consumer price index (CPI) excluding fresh food ("core inflation") over the current and next fiscal years (from April to March of the following calendar year) along with other major macroeconomic variables including GDP growth. Private forecasters are surveyed monthly, with the survey period spanning the last few days of a month and the first few days of the following month, and the mean of the forecasts is published about a week after the close of the survey. For the purposes of this study, medians have also been made available to us. We focus on the median of these forecasts as the principal summary statistic: the choice is based on the fact that the Bank of Japan forecasts are also summarized by the median of forecasts of policy board members. Medians are also less susceptible to the influence of outlier forecasts.

3.1.2 Bank of Japan Inflation Forecasts

As mentioned above, our objective is to analyze the effect of the inflation forecasts of Japan's central bank, the BOJ, on inflationary expectations of the private sector. In October 2000, the BOJ began to publish summary statistics of the internal forecasts made by individual members of its policy board for inflation, or the change in annual average level of CPI excluding fresh food ("core inflation") over the current fiscal year. In 2001, the bank also began to release next-fiscal-year forecasts. Initially the Bank of Japan only announced ranges of forecasts, but from 2003 also included the medians of these forecasts. For the purposes of this paper, we focus on the median of the inflation forecasts of the Policy Board.

The frequency with which the forecasts have been provided has changed over time. Next-fiscal-year forecasts were first published annually and then, starting in 2005, on a semiannual basis every April and October. From mid-2008, the forecasts were released in January and July as well, thus increasing the frequency to a quarterly basis. We have collected the historical figures from a number of BOJ publications, including the "Outlook for Economic Activity and Prices" and "Statement on Monetary Policy."

The focus of this paper is on the impact of next-year forecasts—in particular, how changes in BOJ forecasts for the next fiscal

Table 1. Bank of Japan's Forecasts and ESP Forecasts

	Bank of Japan's Forecasts	**Private Sector's Forecasts**
Source	BOJ Publications (e.g., "Outlook for Economic Activity and Prices," "Statement on Monetary Policy")	Japan Center for Economic Research ("ESP Forecast")
Frequency	October 2000–April 2008: Semiannually. July 2008–Now: Quarterly	May 2004–Now: Monthly
Forecast Variable	Annual Core Inflation (i.e., Headline Inflation Excluding Fresh Food)	Annual Core Inflation
Forecast Horizon	Current and Next Fiscal Years; Two-Year-Ahead Forecasts from October 2008	Current and Next Fiscal Years; Two-Year-Ahead Forecasts are available from time to time
Data Level	Range and Median of Individual Forecasts	Mean and Median of Individual Forecasts; Individual Forecasts are also available

Sources: Bank of Japan; Japan Center for Economic Research.

year influence the private sector's forecasts for the same periods.[10] Current-year forecasts are also available, but their movements reflect changes in realized inflation outcomes as much as changes in the outlook. Further, central banks usually are concerned with medium- to long-term inflation expectations, for which the next-year forecasts are a much better proxy. The features of the BOJ and the forecasts from the JCER survey are summarized in table 1.

[10]Two-year-ahead inflation forecasts have been regularly provided by the JCER from July 2013 and by the BOJ since October 2008 but are not used in this study due to the limited sample size.

3.1.3 Control Variables

We include monthly control variables in regression analyses that, in addition to the Bank of Japan forecasts, should also regularly shape private-sector inflation expectations. Particularly when assessing the impact of BOJ forecasts, it is important to control for significant changes to macroeconomic and financial market conditions that might affect inflationary expectations.

The main control variables that we include in this study are as follows:

Inflation "Surprises" from the Monthly CPI Releases ($InfSurp_t$). An inflation surprise is defined as the currently realized year-on-year quarterly core inflation minus the latest mean inflation forecast for that quarter from the ESP survey. Realized quarterly core inflation is calculated as the year-on-year change in the average core CPI level for the months of that quarter. When the core CPI level is only available for the first month or first two months of a quarter, realized inflation is the year-on-year change in the average core CPI level for which realized data are available. A positive surprise may lead the private sector to upgrade its inflation outlook. Pedersen (2015) shows that surprises in monthly released data affect current-year inflation expectations of private forecasters but not their next-year inflation expectations.

Changes in the Expected Yen Exchange Rate ($\Delta e^{esp}_{t,\,ny}$, ny for Next Year). We measure the log change in the expected yen–dollar rate between two consecutive ESP surveys for the next fiscal year. Expected depreciation of the Japanese yen might exert some upward pressure on inflation in Japan via exchange rate pass-through, while appreciation could work in the opposite direction.

Changes in the Spot Oil Prices (Δoil^{spot}_t) and Average Futures Oil Prices for the Next Fiscal Year (Δoil^{ny}_t). We measure the log changes in the spot prices as well as in the average prices of future contracts with delivery in the next fiscal years for West Texas Intermediate (WTI) crude oil.[11] Both the inflation forecasts made by the BOJ and by the private sector incorporate expected movements in energy prices. Changes in spot oil prices,

[11] See appendix table A.1 for the full description of variables, including details on how the average prices are calculated.

as well as changes in oil price expectations, as reflected in futures prices, could shape the private sector's inflationary expectations.

We also include the lag of the change in inflationary expectations to control for persistence in the movement of inflationary expectations. A delayed response by the forecasts of professional forecasters to macroeconomic shocks, consistent with information rigidities and rejecting the null hypothesis of full information, has been documented by Coibion and Gorodnichencko (2012).[12]

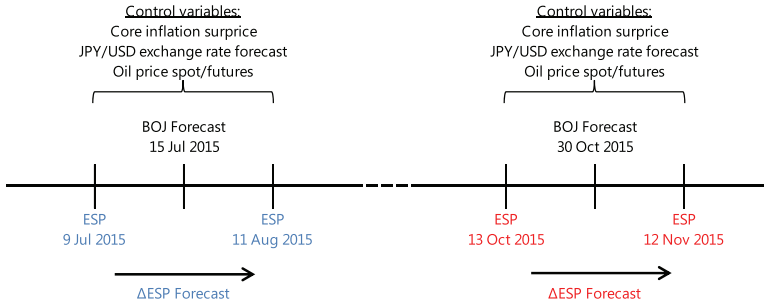
The Introduction of Inflation Targeting (IT). The full sample goes from 2004 (when the ESP survey began) to end-2016; the BOJ's adoption of inflation targeting covers only the final part of the full sample period. On January 22, 2013, the BOJ set an inflation target of 2 percent, and within a few months had introduced a regime of quantitative and qualitative easing measures (QQE) with the explicit objective of achieving that target in two years.[13] By including simple and interactive dummies, our empirical model will take into account the adoption of inflation-targeting policy during the sample period, with a view towards shedding light on the effect it may have had on the relationship between central bank and private-sector forecasts.

The Lehman Brothers Default Shock. While we include many variables in the specification, we do not want to rule out the possibility that during certain extreme events, changed forecasts by the Bank of Japan and private-sector forecasts may show some spurious relationship due to factors outside the model. One plausible example of this is the Lehman Brothers default of September

[12]Townsend (1983) also discusses how learning mechanisms can convert serially uncorrelated shocks into serially correlated movements in economic decision variables.

[13]Since March 2006, the Bank had adopted a numerical reference (1 percent CPI inflation) as "understanding of price stability"; in February 2012, the Bank had switched that understanding to "inflation goal"; in January 2013, to "inflation target"; and the explicit time commitment of two years was only announced in April 2013. See appendix I of Nishizaki, Sekine, and Ueno (2014) and Hattori and Yetman (2017) for changes in exact wordings of these numerical reference points. Among them, the introduction of the 2 percent inflation "target" stood out as the most significant change in the monetary policy framework compared with the 1 percent inflation "understanding" or "goal." The (unreported) recursive breakpoint Chow test indicates that this is the timing when the structural break occurred in the BOJ inflation forecast.

Figure 1. Illustration of Matching Procedure and Methodology



Note: The dates under BOJ forecast and ESP indicate the date when the forecasts were published.

2008, after which business and consumer sentiment plunged dramatically. For this reason, we also report a regression model for a sample that excludes the two monthly observations immediately after the Lehmann shock.

Tax Delay Dummies. All monthly specifications include period dummies for December 2014 as well as June 2016, since very large ESP forecast changes in those months reflected announced delays of the consumption tax hike not yet reflected in the lower-frequency BOJ forecasts.

3.2 Empirical Strategy

The empirical approach is as follows. To ensure the data are aligned correctly, we match each publication of BOJ forecasts with two sets of ESP forecasts: one that comes from the survey date right before the release date of the BOJ forecast and one that comes from the survey date right after the release of BOJ forecast. The matching procedure for two successive dates is illustrated in figure 1. Combined with the intervening months for which there are no BOJ forecasts, the overall result is 150 monthly observations of ESP forecast changes, 42 of which are matched with 42 releases of BOJ forecasts between 2004 and 2016.

We take the monthly change in the median of ESP forecasts for the next fiscal year, $\Delta\pi^{esp}_{t,ny}$, as the dependent variable in our

main regression model. The key explanatory variable is the difference between the median of the BOJ forecasts and the ESP forecasts in the survey right before the release of the BOJ forecasts ($\pi^{boj}_{t-1,ny} - \pi^{esp}_{t-1,ny}$). During the intervening months when there are no BOJ forecasts, this variable is set to zero to reflect the view that in the months without a forecast the information content in the difference should be nil.[14] Using this explanatory variable in a regression allows us to assess the degree to which private analysts adjust their expectations in response to the deviation of the biannual or quarterly BOJ forecasts from their own forecasts. If the degree of adjustment is significant, even after controlling for other factors, then this is consistent with the hypothesis that the private sector believes that the BOJ forecasts contain some valuable information about the economy beyond changes to the private sector's existing information set (as captured by the control variables in figure 1).

We examine the bilateral relation (without controlling for other factors) between the previous difference of the BOJ and the ESP forecasts (horizontal axis) and the change in the ESP forecasts (vertical axis) for the subset of months in which there is a BOJ forecast in figure 2. Indeed, a positive relation is apparent, which suggests that private forecasters may in fact have changed their forecasts in response to the newly released BOJ forecasts. Of course, this relationship needs to be examined more carefully in the monthly frequency multivariate regression model to follow, which controls for other determinants of inflation expectations.

4. Forecast Performance

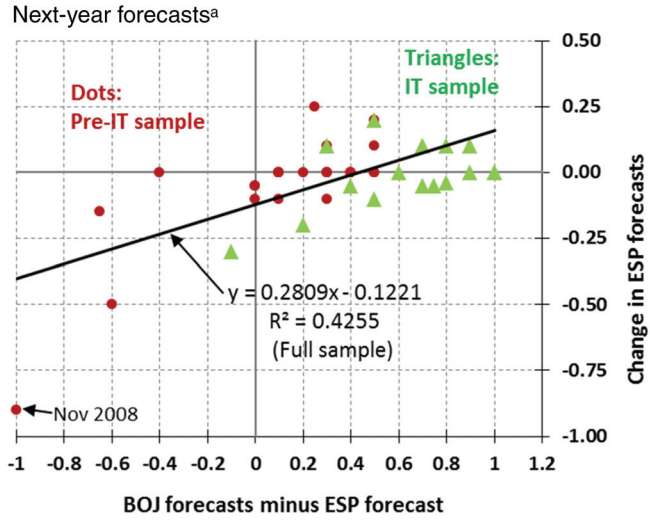
4.1 The Relative Accuracy of BOJ Forecasts

Before going to the regression analysis, we examine the performance of Bank of Japan and private-sector forecasts for CPI inflation and, for comparative reference, GDP growth.

As referred to above, extant research shows that Bank of Japan forecasts influence private-sector forecasts (e.g., Fujiwara 2005 and subsequently Hubert 2015). This influence could have been due to

[14] An alternative treatment of the variable, where the difference is set to the difference between the last available BOJ forecast and the latest ESP forecast, yields qualitatively very similar results.

Figure 2. Responsiveness of ESP Forecasts to the Difference between BOJ Forecasts and ESP Forecasts in the Previous Survey[a] (in percentage points)



[a]Changes in ESP forecasts refer to the changes in the median of forecasts of core inflation by private forecasters responding to the ESP surveys—one before the BOJ forecasts release and one after that. BOJ forecasts refer to the median of forecasts of core inflation by BOJ policy board members. BOJ forecasts minus ESP forecasts refer to the differences between BOJ forecasts and the ESP forecasts in the survey prior to the release of BOJ forecasts.
Sources: Bank of Japan; Japan Center for Economic Research; authors' calculations.

a prevailing view that the Bank of Japan forecasts were superior to private-sector forecasts, and in some sense based on a superior information set. Such a superior information set could of course include inside knowledge about the future direction of policy, though it is worth noting that officially Bank of Japan forecasts are made with reference to the view of market participants regarding the future course of policy. However, shortly after the adoption of the inflation-targeting regime, the Bank of Japan changed its forecast assumptions to include judgments of the Bank about the effects of past policy decisions.[15]

[15]From October 2000 through October 2005, Bank of Japan forecasts were based on the assumption that there will be no change in monetary policy; from

That said, in the pre-IT era, Bank of Japan forecast accuracy appears to be roughly similar to that of private-sector economists. Table 2, top panel, summarizes the mean errors and root-mean squared errors (RMSE) of the private-sector forecasts and the Bank of Japan forecasts for inflation during both the 2004–12 (pre-IT) and the 2013–16 (IT) periods. During the pre-IT period, the private-sector forecasts have lower mean error and RMSE than the BOJ's, but in both cases the differences are statistically insignificant.

Given the results in the literature that Bank of Japan forecasts influence those of the private sector, what the above findings confirm is that the impact of the Bank of Japan forecasts need not be due to a strictly superior information set or forecasting technology than that of the private sector. Rather, information that the Bank of Japan conveyed via its forecasts could be viewed as complementary to that of the private sector, and thus have an impact on the margin.

What about after the implementation of the inflation-targeting policy? The private-sector forecasts now have consistently lower mean error and RMSE than those of the Bank of Japan. Further, the differences in mean error and RMSE are statistically significant at the 5 percent level. The errors in the Bank of Japan's forecasts for inflation in the IT era—which now explicitly incorporated the Bank's assessment of the impact of past policy decisions—were invariably due to their being too high relative to realized inflation.

There is a striking asymmetry in forecast accuracy results when we examine forecasts of GDP instead of forecasts of inflation (table 2, bottom panel). Unlike the case of the CPI forecast, the BOJ's GDP forecast did not deteriorate after the introduction of inflation targeting; rather, it actually improves, as does that of the private sector. Further, the BOJ's GDP forecast performance is statistically indistinguishable from the ESP's GDP forecast, both in terms of the mean forecast error and RMSE. This is in stark contrast to the relative accuracy of the CPI measures.

April 2006 through January 2013, forecasts were in reference to the view of market participants regarding the future course of the policy rates, as incorporated in market interest rates. From April 2013 to the present, the forecasts were made assuming the effects of past policy decisions and with reference to views incorporated in financial markets regarding future policy.

Table 2. Accuracy of Next-Year Forecast[a] (in percentage points)

	2004–16		Of Which:			
			Before Inflation Targeting		Inflation-Targeting Period[c]	
	BOJ	**ESP**	**BOJ**	**ESP**	**BOJ**	**ESP**
Core Inflation						
Mean Forecast Error[b]	0.6409	0.3099*	0.3401	0.1940	1.2296	0.4983**
Root Mean Squared Error[b]	1.0788	0.8394	0.8843	0.8515	1.3357	0.8193**
Real GDP Growth						
Mean Forecast Error[b]	0.8976	0.7214	1.0038	0.9077	0.7250	0.4188
Root Mean Squared Error[b]	1.8676	1.8009	2.1431	2.1498	1.3010	1.0016

[a]Comparison of the BOJ forecasts and matching ESP forecasts, taken in the survey right after the release of BOJ forecasts. An alternative comparison which matches BOJ forecasts instead with the ESP forecasts immediately before the BOJ forecast release does not significantly affect the results.
[b]Forecast errors are calculated by subtracting realized inflation (real GDP growth) rate from forecasts, i.e., a positive forecast error indicates the realized inflation (real GDP growth) rate is smaller than the forecast. Sample includes forecasts made in 2004–2016.
[c]As IT was announced on 22 January 2013, the IT period sample for matched BOJ and ESP forecasts starts from the January 2013 BOJ forecasts and the subsequent ESP forecasts.
** and * indicate the difference between BOJ forecast and ESP forecast is significant at 5 percent and 10 percent levels, respectively (t-test).
Sources: Bank of Japan; authors' calculations.

4.2 Evidence of a Structural Break

To investigate further the connection between the introduction of the inflation target and the poor performance of official forecasts, we test for a structural break in the Bank of Japan's inflation forecast series.[16] The break is posited to be when the BOJ introduced the 2 percent inflation-targeting regime in January 2013. Based on the breakpoint Chow test, the null hypothesis of no break in the BOJ forecast series for CPI at that time is rejected at the 1 percent significance level (p-value, 0.0055). By contrast, BOJ forecasts for GDP show no evidence of a structural shift (p-value, 0.9736).

At the same time, private-sector forecasts for CPI also show evidence of a structural break, not shared by their forecasts for GDP (p-values, 0.0020 and 0.2363, respectively).

In line with these results, the coefficient on an inflation-targeting dummy, which takes on the value of one since January 2013, is positive and significant at the 1 percent level for both the BOJ and private-sector forecasts in the following simple regression:

$$\pi^{boj}_{t,ny} \text{ or } \pi^{esp}_{t,ny} = Constant + IT\ Dummy + u_t. \tag{1}$$

However, the shift of Bank of Japan inflation forecasts is larger than that of private forecasts: the obtained coefficients on the IT dummy are 1.27 for the BOJ and 0.75 for the private sector. This implies that the wedge between BOJ and ESP inflation forecasts increased by around 0.5 percentage point on average after the adoption of inflation targeting.

This pattern of significant structural change for the Bank of Japan inflation forecasts, not replicated in their GDP forecasts, is consistent with the view, alluded to earlier, that the adoption of IT in early 2013 was the result of an exogenous political event, which then appears to have caused a change in the inflation forecasts by the BOJ (but not similarly for the GDP forecast). As a result, the private sector also adjusted its inflation forecasts, but less so than

[16]For core CPI forecasts, those without consumption tax effects are used to avoid detecting spurious structural change. For ESP, April to September 2013 where those excluding consumption tax effects were not surveyed, the series is adjusted by another time dummy for the corresponding period. For real GDP, the outliers after the Great Financial Crisis (February and March 2009) and the China shock (April and May 2016) are adjusted by time dummies.

the Bank of Japan. This larger shift of the Bank of Japan inflation forecast resulted in its relatively poor forecast performance.

5. Regression Analysis

In this section, we examine how the private sector corrected for the incremental increase in the BOJ inflation forecast with the advent of inflation targeting.

5.1 Baseline Specification

As noted above, the principal regression equation takes as the dependent variable the monthly change in the median of ESP inflation forecasts for the next fiscal year $\Delta\pi^{esp}_{t,ny}$. For the explanatory variables, the key explanatory variable of interest is the difference between a fresh BOJ median forecast for the next year (available on a biannual or, later in the sample, quarterly basis) and the median ESP forecast, or $(\pi^{boj}_{t-1,ny} - \pi^{esp}_{t-1,ny})$. As explained above, for months when a fresh BOJ forecast is not available, this variable is set at zero to reflect the notion that there should be no additional information content. As previously mentioned, we also include a number of control variables for monthly changes in the economy and financial markets: inflation "surprises"; changes in the expected yen exchange rate; and changes in oil prices, both spot and future.

$$\Delta\pi^{esp}_{t,ny} = Constant + \beta_1\Delta\pi^{esp}_{t-1,ny} + \beta_2 InfSurp_t + \beta_3\Delta e^{esp}_{t,ny} + \beta_4\Delta oil^{ny}_t \left(or\ \Delta oil^{spot}_t\right) + \beta_5\left(\pi^{boj}_{t-1,ny} - \pi^{esp}_{t-1,ny}\right) + u_{t.} \tag{2}$$

The estimation results for the inflation forecasts are reported in table 3. We first report models for inflationary expectations without considering BOJ forecasts. The change in oil prices—whether via the spot (column 1) or futures (column 2) channel—has the right sign in that a positive change leads to an upward adjustment of the private sector's forecasts of inflation. Since the coefficient on the oil futures prices variable is statistically significant while that on the spot oil price is not, for the rest of the paper we mainly rely on the oil futures price as a factor shaping inflationary expectations. The inflation surprise coefficient also has the right sign but is not quite statistically

Table 3. Baseline Specification: Next-Year Forecasts

	(1)	(2)	(3)	(4)	(5)
Constant	−0.0188*	−0.0196**	−0.0337***	−0.0290***	−0.0217**
	(0.0096)	(0.0098)	(0.0113)	(0.0098)	(0.0092)
Lagged Dep. Variable	0.2523**	0.2353*	0.2265**	0.1958**	0.2573***
	(0.1226)	(0.1217)	(0.1093)	(0.0988)	(0.0939)
Inflation Surprise	0.1117	0.1169	0.1227*	0.1058	0.1031
	(0.0784)	(.0763)	(0.0740)	(0.0706)	(0.0677)
Change in USD Forecast	0.0241***	0.0239***	0.0199***	0.0211***	0.0166**
	(0.0086)	(0.0082)	(0.0070)	(0.0065)	(0.0064)
Change in Spot Oil Price	0.0032				
	(0.0021)				
Change in Oil Price Forecast		0.0044*	0.0041**	0.0032**	0.0017
		(0.0026)	(0.0020)	(0.0015)	(0.0014)
Diff (BOJ–ESP)			0.1545***	0.3140***	0.1923***
			(0.0480)	(0.0879)	(0.0553)
Diff (BOJ–ESP)*Dummy IT				−0.1186	0.0120
				(0.1082)	(0.0858)
Dummy IT				−0.1002**	−0.1100**
				(0.0468)	(0.0531)
Obs.	150	150	150	150	148
R^2	0.5556	0.5630	0.6200	0.6628	0.6393
Adj. R^2	0.5369	0.5446	0.6013	0.6412	0.6158

Notes: Equation (5) excludes the first two observations after Lehman Brothers' bankruptcy. Tax dummies for December 2014 and June 2016 to reflect announced delays in consumption tax hike included in regression though coefficients not reported. Figures in parentheses indicate standard errors. ***, **, and * indicate significance levels at 1 percent, 5 percent, and 10 percent, respectively.

significant. On the other hand, changes in the expected yen exchange rate do significantly affect inflation expectations: the coefficient suggests that a 10 percent depreciation of the yen exchange rate would be associated with a 0.24 percentage point increase in expected inflation. The lagged dependent variable is statistically significant as well, consistent with a partially delayed response of professional forecasters to new information. The adjusted R-squared for the expectations models without Bank of Japan forecasts approximate to 54 percent in both cases.[17]

In column 3, we include the main explanatory variable ($\pi^{boj}_{t-1,ny} - \pi^{esp}_{t-1,ny}$) and find it is statistically significant at the 1 percent level. Even after controlling for other information that might have influenced expectations between the two ESP forecasts, the private-sector forecasters do indeed appear to take into account the degree to which recent Bank of Japan forecasts differ from their own previous forecasts when updating their own forecasts. The size of the coefficient on the variable suggests that on average for every 1 percentage point increase in the differential between BOJ and ESP forecasts in the month of the BOJ forecast, the private-sector forecasters would raise their own forecast by around 0.15 percentage point. The adjusted R-squared increases from 54 percent to 60 percent when consideration is made of the Bank of Japan forecasts, as shown in column 3.

As discussed above, it is likely that the specification is incomplete due to shifts in the monetary policy regime. We thus extend the

[17] In unreported specifications, we also included expected real GDP growth and the forecast long-term interest rate, but they were not consistently significant, nor did they change the main results. We also tried and found to be statistically insignificant the level of the forecasted variable (inflation), a measure of economic slack (the unemployment rate), a policy rate instrument (the call rate), actual inflation volatility, forecasted stock prices (TOPIX), and forecasted money supply (M2). Statistical tests reject significant (first-order) autocorrelation of the residuals in the major specifications. Decomposition of the differenced explanatory variable into separate private-sector and central bank forecasts resulted in small and statistically insignificant differences in the absolute value of the coefficients. We also ran robustness checks that confirmed that adjusting for the consumption tax hike (both ESP and the BOJ release forecasts net of the expected impact of the consumption tax hike of 2014), or including inflation volatility or a dummy for the inflation goal period did not change the main conclusions. The results are available upon request.

main regression equation by allowing for the impact of the central bank forecasts to change after the BOJ adopted inflation targeting.

$$\begin{aligned}\Delta\pi^{esp}_{t,ny} = {} & Constant + \beta_1\Delta\pi^{esp}_{t-1,ny} + \beta_2 InfSurp_t + \beta_3\Delta e^{esp}_{t,ny} \\ & + \beta_4\Delta oil^{ny}_t + \beta_5\left(\pi^{boj}_{t-1,ny} - \pi^{esp}_{t-1,ny}\right) \\ & + \beta_6\left(\pi^{boj}_{t-1,ny} - \pi^{esp}_{t-1,ny}\right) * Dummy\ IT \\ & + \beta_7 Dummy\ IT + u_t \end{aligned} \tag{3}$$

Column 4 reports the estimation results for the regression equation which adds both a period dummy which is one when inflation targeting was in effect (i.e., starting from the ESP survey in February 2013), and an interaction term which is the product of this dummy and the main explanatory variable. The two additional variables are intended to capture the fact that introduction of the IT regime could have affected the impact of the BOJ forecasts in two ways: it could have led the private sector to view the BOJ forecasts as consistently biased (shift in the constant), or it could have reduced the impact of the changes in BOJ forecast (the slope).

The economic significance of the main explanatory variable increases, as the coefficient on the variable rises from around 0.15 to 0.31. Namely, the current specification suggests that private forecasters increase their next-year forecast by 0.31 percentage point in response to a 1 percentage point increase in the difference between the BOJ forecast and ESP forecast.

At the same time, the sign of the coefficients for the added terms suggests that the impact of the Bank of Japan forecasts has been transformed since the introduction of the inflation-targeting policy. The interaction term in column 4 is negative, as is the coefficient for the IT dummy, statistically significantly so in the case of the IT dummy. This latter coefficient is robust to the deletion of the first two months' observations after the Lehman failure from the sample (column 5).[18]

[18]We also ran a separate set of (unreported) regressions using similar specifications for the BOJ and ESP GDP forecasts. In contrast to the effect on inflation forecasts, the impact on GDP forecasts and their determinants from the introduction of an inflation-targeting regime was minimal. The results are available upon request.

Numerical impacts are calculated as follows: ceteris paribus, a 1 percentage point increase in the central bank forecasts corresponds to around a 0.30 percentage point increase in those of the private sector (column 4). As discussed earlier with regard to equation (1), the wedge between BOJ and ESP inflation forecasts ($\pi^{boj}_{t,ny} - \pi^{esp}_{t,ny}$) increased by around 0.5 percentage point on average after the adoption of inflation targeting, which would imply a boost to ESP forecasts by 0.15 percentage point during the IT regime. At the same time, however, the coefficient on the IT dummy implies that the private sector is discounting the central bank forecasts by 0.10 percentage point.[19] The calculation suggests that an increase in BOJ inflation forecasts after the adoption of inflation targeting likely raised ESP inflation forecasts by only a small margin (0.05 percentage point). Similar calculations using the coefficients when controlling for the Lehman episode (column 5) result in no margin left, i.e., private-sector forecasters completely discounted the increase in BOJ inflation forecasts from the start of the IT era.

Japan's limited experience with inflation targeting has for the most part coincided with quantitative and qualitative easing policies. A factor to keep in mind is that the private sector's forecasts for long-term inflation rates in Japan had been well below 2 percent for many years. The negative sign on the IT dummy coefficient likely reflected more pessimistic views among private-sector forecasters on the ability of measures to achieve the 2 percent inflation target from below—efforts which were in many respects unprecedented—while the Bank of Japan was focused on communication consistent with achieving its target, or so-called Odyssean forward guidance. These competing incentives may have made forecasting more difficult and hence led to a decline in accuracy of forecasts and lower confidence in BOJ forecasts.

[19] An alternative interpretation of the result is that the introduction of IT may have influenced other variables, which account for the negative coefficient on the IT dummy beyond the change in central bank forecasts. However, tests do not support structural change in any of the other explanatory variables, nor is the null hypothesis of no change in the coefficients on the other explanatory variables in the regression rejected.

Another possibility is that the central banks' forecasting models for the overall macroeconomy simply deteriorated in 2013 with the introduction of variety of unprecedented monetary policy measures whose transmission mechanisms were untested, and there was less confidence in the precision of central bank's economic forecasts in general rather than inflation forecasts in particular. However, as discussed above, we do not find evidence for a structural break in GDP forecasts, nor any change in the influence of BOJ forecasts for GDP, at the start of the IT era.

5.2 Alternative Specification

As a robustness check, we report the results from running the alternative regressions using quarterly ESP forecasts instead of at the monthly frequency. As the Bank of Japan forecasts are mostly at the quarterly frequency, this allows for a differenced specification where the change in the Bank of Japan forecast is one of the explanatory variables.[20]

Since the Bank of Japan forecast observations are only available at a lower frequency than the rest of the sample, the estimate of the impact of the Bank of Japan forecasts can be subject to noise using monthly data.[21] On the other hand, by using quarterly data in a small sample, the researcher may lose some precision in the estimates of the determinants of the change in private-sector forecasts. With this caveat in mind, we examine the results for next-year forecasts in table 4, but using only those months for which the BOJ forecasts are available. We estimate the regressions in differences, where the dependent variable is the change in the private-sector forecast medians over the period, and the main explanatory variable

[20]The alternative quarterly specification is estimated only over the time period during which the BOJ was issuing forecasts at a quarterly frequency (July 2008 onwards).

[21]This would be particularly the case if one expected the impact of the control variables to be different in periods with and without BOJ forecasts. However, statistical tests reject the hypothesis that the coefficients of the control variables differ in the periods when there are Bank of Japan forecast announcements.

Table 4. Alternative Specification: Next-Year Forecasts, Quarterly

	(1)	(2)	(3)
Constant	−0.0039	−0.0219	−0.0215
	(0.0109)	(0.0160)	(0.0161)
Inflation Surprise	0.2139*	0.2584**	0.2618**
	(0.1082)	(0.1230)	(0.1237)
Change in USD Forecast	0.0119**	0.0071	0.0071
	(0.0054)	(0.0072)	(0.0072)
Change in Oil Price Forecast	0.0010	0.0010	0.0007
	(0.0021)	(0.0020)	(0.0026)
Change in BOJ Forecast	0.7564***	0.7116***	0.7043***
	(0.0989)	(0.0883)	(0.0916)
Change in BOJ Forecast*Dummy IT		0.1317	0.1446
		(0.9482)	(0.1573)
Dummy IT		0.0413*	0.0409*
		(0.0220)	(0.0220)
Obs.	34	34	33
R^2	0.8553	0.8718	0.8520
Adj. R^2	0.8353	0.8433	0.8178

Notes: Equation (3) excludes the first observation after Lehman Brothers' bankruptcy. Changes in the USD forecast and oil price forecast are computed for periods corresponding to the quarterly changes in the ESP forecast. Figures in parentheses indicate standard errors. ***, **, and * indicate significance levels at 1 percent, 5 percent, and 10 percent, respectively.

is now the change in the Bank of Japan forecasts over the period between forecasts.[22]

$$\Delta\pi^{esp}_{t,ny} = Constant + \gamma_1 InfSurp_t + \gamma_2 \Delta e^{esp}_{t,ny} + \gamma_3 \Delta oil^{ny}_t + \gamma_4 \Delta\pi^{boj}_{t,ny} + u_t \quad (4)$$

As in the baseline regressions, a dummy for the IT regime, as well as a variable interacting this regime dummy with the main explanatory variable of interest—in this case, the change in the BOJ inflation forecasts—are included in latter specifications.

[22]While the breakpoint Chow test detects a structural shift in both $\pi^{boj}_{t,ny}$ and $\pi^{esp}_{t,ny}$ as previously discussed, the same Chow test does not find a shift in their first difference ($\Delta\pi^{boj}_{t,ny}$ and $\Delta\pi^{esp}_{t,ny}$). This can happen if $\pi^{boj}_{t,ny}$ and $\pi^{esp}_{t,ny}$ have a one-time stepwise shift. Thus, the differenced explanatory variable would lead us to expect a different impact from the IT dummy in table 4 than in table 3.

Dependent-variable own lag is not included in the quarterly specification, as private forecasters do not appear to be adjusting their forecasts at such long lags; further, Durbin-Watson statistics close to 2 for the key specifications of table 4's regressions provide no evidence that the error terms are positively autocorrelated.

The impact of the change in Bank of Japan forecasts is statistically significant, with coefficients of around 0.70–0.76, suggesting that more than two-thirds of changes in the BOJ forecasts are passed through to changes in the ESP forecasts (table 4, columns 1–3). The adjusted R-squared of over 0.8 in all specifications suggests high degrees of explanatory power. The signs of the control variable coefficients are unchanged, and generally the same control variables that are statistically significant in the earlier regressions are also significant in the quarterly difference regressions.

Important points to notice are (i) the coefficient on the variable interacting the BOJ forecast change with the IT dummy is not statistically significant, and (ii) the IT dummy on its own is positive, but at 0.04 (columns 2–3) corresponds to a miniscule 0.01 percentage point on a monthly frequency. The first point is consistent with the observation that the interactive variable is also not significant in the earlier baseline specification (table 3, columns 4–5). The second point is also consistent with the baseline result that private-sector inflation forecasts were not raised meaningfully even after the Bank of Japan raised its inflation forecasts upon the adoption of inflation targeting. That is, in the baseline specification, the impact of the wider wedge between BOJ and ESP inflation forecasts was effectively cancelled by the level shift. For these reasons, this alternative specification is consistent with the baseline specification's result that private-sector forecasters discounted the increase in BOJ inflation forecasts in the IT era. However, that aspect is not so clearly seen in this alternative specification, as its explanatory variable, the first difference in the BOJ's inflation forecast $\Delta\pi^{boj}_{t,ny}$, largely conceals the shift in its level $\pi^{boj}_{t,ny}$ (see footnote 22).

6. Conclusion

The impact of central bank inflation forecasts on those of the private sector can be influenced by the introduction of an inflation-targeting

regime in numerous ways. If the target is particularly credible, the usefulness of the central bank forecasts might be reduced due to their diminished information value. But if the target is not viewed as achievable, and central bank forecasts are viewed as influenced by the target, once again the usefulness of the forecasts might be affected.

We argue that our results are more consistent with the latter channel: there was a structural upward shift in BOJ inflation forecasts following the adoption of inflation targeting in 2013—reflecting the incentive of the central bank to communicate its intent to achieve the target—that affected their use by the private sector. The fact that forecast assumptions were changed at the time to include the central bank's judgment of "the effects of past policy decisions" was yet another aspect of the IT regime that could have diminished their value to the private sector. The decline in the accuracy of central bank forecasts in the IT era versus those of the private sector is consistent with such a structural shift. And the systematic *downward* discounting of the central bank forecasts that followed suggests that private-sector forecasters likely viewed the BOJ forecasts as upwardly biased. By contrast, the inability of private-sector expectations of inflation to rise beyond 1.5 percent for any extended period after the announcement of the 2 percent inflation target is prima facie evidence that it wasn't the introduction of a *credible* target that could have been responsible for any change in the influence of central bank forecasts.

We view Japan's situation as increasingly relevant and the results as generally useful. Since the global financial crisis, inflation levels in both advanced and many emerging economies have been persistently weak and below established targets. One after another, advanced economies adopted unconventional monetary policies whose effectiveness was untested. Further, the inflation forecasts of many monetary authorities, including the U.S. Federal Reserve, have repeatedly been higher than both observed inflation and the forecasts of the market. One renowned scholar and Fed watcher has even suggested that market participants might see the Federal Reserve forecasts "as a disconnect from reality" (Summers 2016). The undershooting of inflation outcomes from the forecasts and targets laid out by central banks is by now a widespread phenomenon, which can hardly be viewed as unique to Japan.

Thus, this case study gives us general insights into the relationship between inflationary expectations and central bank and private-sector forecasts, as well as the impact of different monetary policy regimes, especially when the targeted inflation rate is higher than the expected inflation rate and the nominal policy rate is close to an effective lower bound. We hope our findings here will stimulate further research on the impact of central bank forecasts under different policy regimes, as well as the tradeoffs that monetary authority may face when issuing the forecasts.

Appendix

Table A.1. Variable Description

Variable	Variable Description	Sources
$\pi^{esp}_{t,ny}$	ESP inflation forecast at time t for next year, in percent.	JCER
$\pi^{boj}_{t-1,ny}$	The latest BOJ inflation forecast for next year known to ESP survey respondents when they make forecasts at time t, in percent.	BOJ
$\Delta\pi^{esp}_{t,ny}$	Change in ESP inflation forecast between time $t-1$ and t for next year, in percentage points.	JCER; authors' calculations
$\Delta\pi^{boj}_{t,ny}$	Change in BOJ inflation forecast for next year (quarterly in the alternative specification), in percentage points.	BOJ; authors' calculations
$\pi^{boj}_{t-1,ny} - \pi^{esp}_{t-1,ny}$	The latest BOJ inflation forecast for next year known to ESP survey respondents when they make forecasts at time t minus ESP inflation forecast for next year at time t–1.	JCER; BOJ; authors' calculations
$\Delta e^{esp}_{t,ny}$	Log change in ESP JPY/USD exchange rate forecast between time $t-1$ and t for next year, in percent. A positive change indicates depreciation of JPY is expected.	JCER; authors' calculations

(*continued*)

Table A.1. (Continued)

Variable	Variable Description	Sources
Δoil_t^{spot}	Log change in spot WTI oil price between time $t-1$ and t, in percent.	Bloomberg; authors' calculations
Δoil_t^{ny}	Log change in the average of prices of WTI oil futures with deliveries in next fiscal year, between time t–1 and t, in percent. Namely, the log change in the average of future prices of contracts to be delivered in each month of the next fiscal year. The average of future prices is calculated as [F(Apr)+F(May)+...+ F(Feb)+F(Mar)]/12, where F(.) represents the future price of contract to be delivered in a particular month.	Bloomberg; authors' calculations
$InfSurp_t$	Core inflation surprise known at time t, defined as realized quarterly inflation at time t minus quarterly inflation forecasted prior to the release of realized figures, in percent.	Statistics Bureau of Japan; JCER; authors' calculations
DumIT	Dummy variable for inflation target period, equal to 1 for ESP surveys from February 2013 onwards, and 0 otherwise.	
DumTaxDelay	Two separate dummy variables are included to control for delays of consumption tax hike, one equal to 1 for ESP survey of December 2014, and 0 otherwise, the other equal to 1 for the ESP survey of June 2016, and 0 otherwise.	

References

Andrade, P., G. Gaballo, E. Mengus, and B. Mojon. 2018. "Forward Guidance and Heterogeneous Beliefs." BIS Working Paper No. 750 (October).

Blinder, A. S., M. Ehrmann, M. Fratzscher, J. De Haan, and D. Jansen. 2008. "Central Bank Communication and Monetary

Policy: A Survey of Theory and Evidence." *Journal of Economic Literature* 46 (4): 910–45.

Bomfim, A. N., and G. D. Rudebusch. 2000. "Opportunistic and Deliberate Disinflation under Imperfect Credibility." *Journal of Money, Credit and Banking* 32 (4, Part 1): 707–21.

Campbell, J. R., C. L. Evans, J. D. M. Fisher, and A. Justiniano. 2012. "Macroeconomic Effects of Federal Reserve Forward Guidance." *Brooking Papers on Economic Activity* (Spring): 1–80.

Capistran, C., and M. Ramos-Francia. 2010. "Does Inflation Targeting Affect the Dispersion of Inflation Expectations?" *Journal of Money, Credit and Banking* 42 (1): 113–34.

Cecchetti, S. G., and C. Hakkio. 2009. "Inflation Targeting and Private Sector Forecasts." NBER Working Paper No. 15424.

Christensen, J., and M. Spiegel. 2019. "Negative Interest Rates and Inflation Expectations in Japan." FRBSF Economics Letter No. 2019-22, August 26.

Coibion, O., and Y. Gorodnichencko. 2012. "What Can Survey Forecasts Tell Us about Information Rigidities?" *Journal of Political Economy* 120 (1): 116–59.

Crowe, C. 2010. "Testing the Transparency Benefits of Inflation Targeting: Evidence from Private Sector Forecasts." *Journal of Monetary Economics* 57 (2): 226–32.

Dale, S., A. Orphanides, and P. Osterholm. 2011. "Imperfect Central Bank Communication — Information vs. Distraction." *International Journal of Central Banking* 7 (2, June): 3–39.

de Mendonca, H. F., and J. D. B. V. de Deus. 2019. "Central Bank Forecasts and Private Expectations: An Empirical Assessment from Three Emerging Economies." *Economic Modelling* 83 (December): 234–44.

Demertzis, M., and N. Hoeberichts. 2007. "The Costs of Increasing Transparency." *Open Economies Review* 18 (3): 263–80.

Demertzis, M., and N. Viegi. 2008. "Inflation Targets as Focal Points." *International Journal of Central Banking* 4 (1, March): 55–87.

Ehrbeck, T., and R. Waldmann. 1996. "Why Are Professional Forecasters Biased? Agency versus Behavioral Explanations." *Quarterly Journal of Economics* 111 (1): 21–40.

Ehrmann, M. 2015. "Targeting Inflation from Below: How Do Inflation Expectations Behave?" *International Journal of Central Banking* 11 (Supplement 1, September): 213–49.

Ehrmann, M., S. Eijffinger, and M. Fratzscher. 2012. "The Role of Central Bank Transparency for Guiding Private Sector Forecasts." *Scandinavian Journal of Economics* 114 (3): 1018–52.

Fujiwara, I. 2005. "Is the Central Bank's Publication of Economic Forecasts Influential?" *Economics Letters* 89 (3): 255–61.

Hattori, M., and J. Yetman. 2017. "The Evolution of Inflation Expectations in Japan." *Journal of the Japanese and International Economies* 46 (December): 53–68.

Hubert, P. 2014. "FOMC Forecasts as a Focal Point for Private Expectations." *Journal of Money, Credit and Banking* 46 (7): 1381–1420.

———. 2015. "Do Central Bank Forecasts Influence Private Agents? Forecasting Performance versus Signals." *Journal of Money, Credit and Banking* 47 (4): 771–89.

Ito, T. 1990. "Foreign Exchange Rate Expectations: Micro Survey Data." *American Economic Review* 80 (3): 434–49.

Kool, C., M. Middeldorp, and S. Rosenkranz. 2011. "Central Bank Transparency and the Crowding Out of Private Information in Financial Markets." *Journal of Money, Credit and Banking* 43 (4): 765–74.

Laster, D., P. Bennett, and I. S. Geoum. 1999. "Rational Bias in Macroeconomic Forecasts." *Quarterly Journal of Economics* 114 (1): 293–318.

Morris, S., and H. S. Shin. 2002. "Social Value of Public Information." *American Economic Review* 92 (5): 1521–34.

Morris, S., H. S. Shin, and H. Tong. 2006. "Social Value of Public Information: Morris and Shin (2002) Is Actually Pro-Transparency, Not Con: Reply." *American Economic Review* 96 (1): 453–55.

Nishizaki, K., T. Sekine, and Y. Ueno. 2014. "Chronic Deflation in Japan." *Asian Economic Policy Review* 9 (1): 20–39.

Orphanides, A. 2018. "The Boundaries of Central Bank Independence: Lessons from Unconventional Times." Discussion Paper No. 2018-E-10, Institute for Monetary and Economic Studies, Bank of Japan.

Ottaviani, M., and P. N. Sorensen. 2006. "The Strategy of Professional Forecasting." *Journal of Financial Economics* 81 (2): 441–66.

Pedersen, M. 2015. "What Affects the Predictions of Private Forecasters? The Role of Central Bank Forecasts in Chile." *International Journal of Forecasting* 31 (4): 1043–55.

Romer, C., and D. Romer. 2000. "Federal Reserve Information and the Behavior of Interest Rates." *American Economic Review* 90 (3): 429–57.

Shirakawa, M. 2012. "Toward Sustainable Growth with Price Stability." Speech at the Kisaragi-kai Meeting in Tokyo, November 12.

———. 2018. *Central Bank — My Insider Recollections of 39 Years* (in Japanese) (authors' translation). Toyo Keizai Inc.

Siklos, P. 2013. "Sources of Disagreement in Inflation Forecasts: An International Empirical Investigation." *Journal of International Economics* 90 (1): 218–31.

Summers, L. 2016. "Jackson Hole: The Fed Has Not Inspired Faith in Its Policy Framework." Blog Entry, *Financial Times*, August 29.

Townsend, R. M. 1983. "Forecasting the Forecasts of Others." *Journal of Political Economy* 91 (4): 546–88.