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## **Inflation Target and Anchor of Inflation Forecasts in Japan \***

**Shin-ichi Fukuda (University of Tokyo) and Naoto Soma (University of Tokyo)\*\***

### **Abstract**

In literature, a number of studies argued that an explicit inflation targeting regime provides less uncertainty about future inflation rates through anchoring expectations. However, it is far from clear whether the argument still holds true when the central bank faces a serious difficulty in achieving the target. The Bank of Japan (BOJ) is a central bank that has adopted an explicit inflation target but faced a serious difficulty in achieving it. The purpose of this paper is to explore whether the explicit inflation targeting regime could anchor inflation expectations in Japan. In the analysis, we estimate panel Phillips curves by using Japanese forecaster-level data of “ESP Forecast”. We find significant structural changes in how to form inflation expectations. Before the BOJ announced the 2% inflation target, the estimated anchor of inflation expectations was negative. The new target increased the estimated anchor to significant positive values. This suggests that the BOJ’s explicit inflation target could partly anchor inflation expectations. However, the estimated anchor has never reached the target. More importantly it started to decline when it turned out that the 2% target would not be feasible in the short-run. This implies that an explicit inflation targeting needs to be a feasible one to anchor inflation expectations persistently.

JEL code: E58, E31, E37

Key words: Inflation target, The Bank of Japan, Unconventional monetary policy

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## 1. Introduction

In literature, a number of studies argued that an explicit inflation targeting regime provides less uncertainty about future inflation rates than a monetary policy regime without explicit numerical inflation target because it anchors expectations successfully (see, for example, Bernanke et al. [1999])<sup>1</sup>. However, the argument was based on an implicit assumption that the central bank can achieve the explicit inflation target appropriately. Thus it is far from clear whether the argument still holds true when the central bank faces a serious difficulty in achieving its explicit inflation target. Under prolonged deflation, the Bank of Japan (BOJ) is a central bank that has adopted an explicit inflation target but faced a serious difficulty in achieving the target. The purpose of this paper is to explore to what extent the BOJ's explicit inflation target could anchor inflation expectations successfully under the special environments in Japan.

Soon after the BOJ announced the 2% inflation target in the consumer price index (CPI) in January 2013, the CPI inflation rate, which had stagnated below zero for a long time, rose substantially. In April 2014, it reached 1.5% when excluding fresh food but including energy and 0.8% when excluding food and energy. However, it started to decline in the latter half of 2014 when excluding the direct effects of consumption tax hikes. Reflecting oil price decline, it fell below zero in July 2015 when excluding fresh food but including energy. Even when excluding food and energy, it fell below zero in February 2017 ([Figure 1](#)). It is thus likely that the role of the explicit inflation target might have faced substantial structural changes in anchoring inflation expectations in Japan.

To explore possible structural changes, the following analysis assumes that professional forecasters apply an expectations-augmented Phillips curve when they forecast macroeconomic variables in Japan.<sup>2</sup> We then estimate panel Phillips curves by using Japanese forecaster-level data of "ESP Forecast" which is collected by Japan Center of

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<sup>1</sup> Gürkaynak et al. (2010) found that inflation expectations had been more firmly anchored in the United Kingdom -a country with an explicit inflation target- than in the United States -a country with no such target- using the difference between far-ahead forward rates on nominal and inflation-indexed bonds. Using evidence from financial markets and surveys of professional forecasters, Beechey et al. (2011) showed that long-run inflation expectations were more firmly anchored in the euro area than in the United States because a quantitative inflation target could help provide a firmer anchor.

<sup>2</sup> Using survey data from six Asian-Pacific countries, Rülke (2012) reported that professional forecasters applied the Phillips curve when forecasting macroeconomic variables.

Economic Research. ESP Forecast is a monthly survey on the macroeconomic outlook of Japan's economy including real GDP growth rate, core CPI inflation rate, yen-dollar exchange rate, and NY WTI crude oil futures price. Around 40 leading professional forecasters from private institutes in Japan participate in this survey. Estimating the panel Phillips curves for alternative periods, we derive how anchor of inflation expectations changed over time in Japan.

We find significant structural changes in how to form private inflation expectations. Before the BOJ announced the 2% inflation target, the estimated anchor of private inflation expectations was negative. But after the announcement, the new target increased the estimated anchor of inflation expectations significantly. This implies that the announcement of 2% target was successful in anchoring inflation expectations in positive values. However, the estimated anchor has never reached the target. More importantly it started to decline in 2015. It is likely that when it turned out that the 2% target would not be feasible in the short-run, Japanese forecasters came to place little weight on the 2% target in forming their inflation expectations. The result implies that an explicit inflation targeting regime can provide less uncertainty about future monetary policy actions only when it is a feasible target.

In literature, a number of studies used survey data of inflation expectations to examine whether the adoption of inflation targeting had helped to anchor inflation expectations. The results are mixed depending on whose inflation expectations were used in the analysis. Using survey data of firm managers and households, Kumar et al. (2015) found that the inflation expectations were not well anchored even in successful inflation targeting regime. In contrast, using survey data from Consensus Economics, Johnson (2002, 2003) showed that the expected inflation of professional forecasters was stabilized after the announcement of targets. Using the Consensus Economics data in Canada and the USA, Yetman (2017) found that an explicit inflation targeting regime provided for less uncertainty about future monetary policy actions to anchor expectations of professional forecasters.<sup>3</sup>

The results are also mixed on the effects of BOJ's dramatic policy changes. Using the QUICK survey system data for market participants, Fujiwara et al. (2015) found no sizable

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<sup>3</sup> In addition to these studies, using Consensus Economics surveys, Levin et al. (2004) showed that for the industrialized economies, inflation target played a significant role in anchoring long-run inflation expectations. Using the data across 36 countries, Davis (2014) demonstrated that the inflation expectations of professional forecasters responded to an exogenous shock much less significantly in inflation targeting period.

difference in perceptions of CPI inflations before and after the introduction of new monetary policy regime. Using an event-study approach, Bundick and Smith (2018) demonstrated that unlike in the USA, forward measures of nominal compensation in Japan continued to drift with news about current inflation even after the Bank of Japan adopted the inflation target. In contrast, Fukuda (2015) showed that financial market expectations changed dramatically after Prime Minister Abe had announced a new monetary policy regime in late 2012. Using survey data from Consensus Economics, Hattori and Yetman (2017) found that after the BOJ announced the 2% inflation target, the estimated anchors across forecasters have tended to rise, along with the dispersion in estimates across forecasters. Our results partly support the view that the BOJ's policy changes increased the anchored inflation expectations significantly. However, they also suggest that their effects were far from satisfactory in achieving the target.

In most advanced economies, inflation targeting had originally been introduced as a device to stabilize inflation at low levels. However, when inflation remained weak persistently, the central bank must bring inflation up to the target. Using survey data across 10 advanced economies from Consensus Economics, Ehrmann (2015) showed that inflation expectations of professional forecasters were not well anchored under persistently low inflation but that they were better anchored in inflation targeting countries. Our results are consistent with his results in that the BOJ's 2% target could raise inflation expectations towards significant positive values. However, we find that the effect did not persist when the BOJ's commitment turned out to be unfeasible. Inflation expectations are likely to be influenced not only by the central bank's target inflation rate but by the public's confidence in the central bank's achievement of the target rate. In Japan, a number of structural problems still underpin chronic low inflation (See, for example, Nishizaki et al. [2014] and Hasumi et al. [2018]). Thus unless solving these structural problems, an explicit inflation targeting could not anchor inflation expectations persistently.<sup>4</sup>

The paper proceeds as follows. Section 2 overviews how the BOJ's monetary policy and its targeted inflation rate changed and Section 3 explains the forecaster-level data of "ESP

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<sup>4</sup> Mehrotra (2009) examined whether price level or inflation targeting would have been appropriate policy choices for Japan during its disinflation and deflation period. Yoshino and Miyamoto (2017) found that the effectiveness of fiscal and monetary policies was weakened when the proportion of retirees becomes larger. Hogen and Okuma (2018) explored why expectations had not been anchored at 2 percent in Japan since the late 1990s.

Forecast”. Section 4 formulates an expectations-augmented Phillips curve and Section 5 discusses how to derive the anchor of inflation expectations by using the data of ESP Forecast. Section 6 shows the estimation results of our panel Phillips curves and Section 7 derives the anchor of inflation expectations. Sections 8 and 9 explore robustness of our estimation results. Section 10 summarizes our main results and refers to their implications.

## 2. The BOJ’s Unconventional Monetary Policy

Before moving to the estimation, this section overviews how the BOJ’s monetary policy and its targeted inflation rate changed after the Global Financial Crisis (GFC) in 2008. As summarized in [Table 1](#), the BOJ adopted a series of unconventional monetary policies after the GFC. In particular, after the introduction of the “Quantitative and Qualitative Monetary Easing (QQE)” on April 4 in 2013, the BOJ became highly aggressive in its policy. It expanded the QQE on October 31 in 2014 and introduced two new frameworks, termed “QQE with a Negative Interest Rate,” on January 29 in 2016 and “QQE with Yield Curve Control” on September 21 in 2016.

The BOJ also increased its targeted CPI inflation rate (the year-on-year rate of change in CPI) after the GFC. On December 18 in 2009, the BOJ clarified that the "medium- to long-term price stability" was around 1% CPI inflation rate and declared that it would never tolerate the inflation rate equal to or below 0 percent. On February 14 in 2012, the BOJ suggested that it would set a goal at 1 percent for the time being. More importantly it announced introducing an explicit 2% inflation target in the CPI on January 22 in 2013. Since the previous target was an implicit rate at around 1 percent, the announcement of the explicit 2% inflation target was a dramatic change in the BOJ’s commitment. In particular, when introducing the QQE on April 4 in 2013, the BOJ made a commitment that it would achieve the CPI price stability target of 2 percent “at the earliest possible time, with a time horizon of about two years.”

After announcing the 2% inflation target, the BOJ increased its estimates on future inflation rates substantially. [Table 2](#) summarizes the BOJ’s point estimates of after-tax core CPI inflation rate (CPI, all items less fresh food, excluding the direct effects of the consumption tax hikes) in each fiscal year after the GFC. In its [Outlook for Economic Activity and Prices](#),

the BOJ announces the point estimates of policy board members' forecasts four times a year: January, April, July, and October (or November). After  $T = 2015$ , the point estimate of the core CPI inflation rate in fiscal year  $T$  starts in April of year  $T-2$  and continues through to April in year  $T+1$ , so that there are 12 forecasts for the same fixed event. Before  $T = 2014$ , the estimate starts in October of year  $T-2$  through to April in year  $T+1$ , so that there are 10 forecasts for the same fixed event.

The table shows two interesting features. First the initial point estimate is in marked contrast before and after announcing the 2% inflation target. That is, the initial point estimate in October of year  $T-2$  was far below 1 percent before  $T = 2014$ , while the initial point estimate in April of year  $T-2$  was around 2 percent after  $T = 2015$ . This implies that the explicit 2% inflation target increased the BOJ's initial point estimate of the CPI inflation rate dramatically. Second the accuracy of the initial point estimate declined substantially after announcing the 2% inflation target. Before  $T = 2014$ , the difference between the initial point estimate in October of year  $T-2$  and the final point estimate in April of year  $T+1$  was small and little biased: 0.4% points in  $T = 2011$ , 0.8% points in  $T = 2012$ , 0.3% points in  $T = 2013$ , and 0% points in  $T = 2014$ . In contrast, after  $T = 2015$ , the initial point estimate in April of year  $T-2$  overestimated the final point estimate substantially. The overestimation amounted to 1.9% points in  $T = 2015$ , 2.4% points in  $T = 2016$ , and 1.2% points in  $T = 2017$ . This implies that the explicit 2% inflation target reduced accuracy of the BOJ's initial estimate of the CPI inflation rate dramatically. The inaccuracy happened because despite the dramatic increases in the monetary base, the QQE could not achieve the price stability target of 2 percent (excluding the direct effects of the consumption tax hikes).

The inaccuracy also happened in the BOJ's projected timing of reaching around 2% inflation rate. Since April in 2015, the BOJ had delayed its projected timing frequently. Until October in 2014, its Outlook for Economic Activity and Prices stated that the projected timing would be "in or around fiscal 2015". But it delayed the timing to "around the first half of fiscal 2016" in April 2015, to "around the second half of fiscal 2016" in October 2015, to "around the first half of fiscal 2017" in January 2016, to "during fiscal 2017" in April 2016, to "around fiscal 2018" in November 2016, and to "around fiscal 2019" in July 2017. In April 2018, the BOJ eventually stopped announcing the projected timing in its statement. The frequent changes in the projected timing of reaching around 2 percent indicate that the BOJ is

a central bank that has adopted an explicit inflation target but faced a serious difficulty in achieving the target.

### 3. ESP Forecast

The purpose of the following sections is to explore to what extent the BOJ's explicit inflation targeting regime could anchor inflation expectations by using "ESP Forecast". ESP (Economy, Society, Policy) Corporation started the survey in May 2004 and the Japan Center for Economic Research (JCER) succeeded it after April 2012. The monthly survey is conducted around the beginning of each month and its result is publicized in the middle of the month. In the sense that it sends questionnaires to professional economists, ESP Forecast is similar to Consensus Economics which has widely been used in literature. But the surveyed economists in ESP Forecast are more specialized in the Japanese economy than those in Consensus Forecast. The forecasted macroeconomic variables include growth rates of real GDP and its components, growth rate of industrial production index, current account, core CPI inflation rate (year-on-year), unemployment rate, Nikkei stock price index, the yen-dollar exchange rate, and NY WTI crude oil futures price.

The quoted forecasts are fixed event forecasts which consist of a panel of forecasts for a set of outturns of a series at varying horizons prior to each outturn. For most variables, when quoting forecasts of the value in fiscal year  $T$ , the forecast origin starts in January of year  $T-1$  and continues through to May in year  $T+1$ , so that there are 29 forecasts for the same fixed event. However, for real GDP growth rate and core CPI inflation rate, when quoting forecasts of the value in fiscal year  $T = 2015, 2016, 2017, \text{ and } 2018$ , the forecast origin starts in June of year  $T-2$  and continues through to May in year  $T+1$ . Thus for real GDP growth rate and core CPI inflation rate in fiscal year  $T$ , there are 34 forecasts for the same fixed event after  $T = 2015$ .<sup>5</sup>

Fixed-event forecasts generally have a seasonal property where the number of forecast horizons is different depending on in which month the forecast is quoted. ESP Forecast also has a property that the number of the fixed events is different depending on in which month the forecast is quoted. The forecasted fixed event includes the values in fiscal years  $T-1, T,$

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<sup>5</sup> Before  $T = 2014$ , the forecast origin started in January of year  $T-1$  even for real GDP growth rate and core CPI inflation rate.



and T+1 when the forecast origin is from January to May in year T, while it includes the values in fiscal years T and T+1 when the forecast origin is from June to December in year T. In addition, after T = 2013, it also includes the value in fiscal year T+2 for real GDP growth rate and core CPI inflation rate when the forecast origin is from June to December in year T.

**Table 3** summarizes basic statistics of the forecasted real GDP growth rate and after-tax core CPI inflation rate from fiscal year 2010 to 2019. It reports average and standard deviation of the forecasted fiscal year T's values quoted in January in year T-1, July in year T-1, January in year T, July in year T, and January in year T+1. For both real GDP growth rate and core CPI inflation rate, the average forecasted value shows substantial variations between January in year T-1 and January in year T+1. But the standard deviation declines as the forecast origin approaches the forecasted year. This implies that the forecasters frequently revise their forecasts incorporating new information and eventually form almost homogeneous forecast. However, the standard deviations decline only modestly until July in year T. This suggests that the fixed event forecasts remain heterogeneous until the realized values become available to the forecasters. Comparing the standard deviations between real GDP growth rate and core CPI inflation rate, the forecasted real GDP growth rates had been more heterogeneous than the forecasted core CPI inflation rate until T = 2014. However, after T = 2015, the forecasted core CPI inflation rate became more heterogeneous than the forecasted real GDP growth rates in January in year T-1 and July in year T-1. This suggests that the BOJ's dramatic policy changes reduced heterogeneity of medium-term GDP growth expectations but increased heterogeneity of medium-term inflation expectations.

#### 4. Basic Model

In the following sections, we explore whether the BOJ's explicit inflation targeting regime could anchor inflation expectations through estimating Phillips curves in Japan. In the analysis, we use an expectations-augmented Phillips curve. Denoting the inflation rate by  $\Pi_t$ , GDP gap by  $\ln Y_t - \ln Y_t^*$ , and supply shocks by  $U_t$ , the Phillips curve is written as follows:

$$(1) \Pi_t = \Pi_t^e + \alpha (\ln Y_t - \ln Y_t^*) + U_t.$$

where subscript  $t$  denotes time period.

In the above equation, we denoted log linearized GDP gap by  $\ln Y_t - \ln Y_t^*$  where  $Y_t$  is real GDP and  $Y_t^*$  is potential real GDP. The term  $\Pi_t^e$  is the expected underlying inflation rate which is independent of GDP gap and supply shocks. It is different from average expected inflation rate because the expected effects of GDP gap and supply shocks are reflected in the expectations of  $\alpha(\ln Y_t - \ln Y_t^*)$  and  $U_t$  respectively. Since it has a feature of expected long-run inflation rate, we call  $\Pi_t^e$  “the anchor of inflation expectations”.

In the following analysis, we assume that forecasters form their inflation expectations by using equation (1). We also assume that when forecasting the macroeconomic values in time  $t$ , they form their expectations based on both public and private information available in time  $t-1$ . Then, defining the forecaster  $j$ 's expectation operator based on information in time  $t-1$  by  $E_{j,t-1}$ , we obtain

$$(2) E_{j,t-1}\Pi_t = \Pi_t^e + \alpha \cdot E_{j,t-1}(\ln Y_t - \ln Y_t^*) + E_{j,t-1}U_t.$$

In the above equation, it is worthwhile to note that there is no expectation operator  $E_{j,t-1}$  for  $\Pi_t^e$ . This is because the anchor of inflation expectations is forecasted based only on public information in time  $t-1$ , so that it is common for all forecasters. We may interpret that superscript  $e$  denotes the expectation operator based only on public information in time  $t-1$ .

We assume that potential real GDP grows at a constant rate in the short-run. Then because of no uncertainty in  $\ln Y_t^*$ , it holds that

$$(3) E_{j,t-1}(\ln Y_t - \ln Y_t^*) = E_{j,t-1}\Delta \ln Y_t - \Delta \ln Y_t^* + (\ln Y_{t-1} - \ln Y_{t-1}^*).$$

where  $\Delta \ln Y_t \equiv \ln Y_t - \ln Y_{t-1}$  and  $\Delta \ln Y_t^* \equiv \ln Y_t^* - \ln Y_{t-1}^*$ . Substituting equation (3) into equation (2), we obtain

$$(4) E_{j,t-1}\Pi_t = [\Pi_t^e + \alpha \{(\ln Y_{t-1} - \ln Y_{t-1}^*) - \Delta \ln Y_t^*\}] + [\alpha \cdot E_{j,t-1}\Delta \ln Y_t + E_{j,t-1}U_t].$$

Equation (4) implies that forecaster  $j$ 's inflation expectation formed in period  $t-1$  consists of two components. One is  $[\Pi_t^e + \alpha \{(\ln Y_{t-1} - \ln Y_{t-1}^*) - \Delta \ln Y_t^*\}]$  which is common for all  $j$ . It is

the sum of the anchor of inflation expectations and  $\alpha \times$ [realized GDP gap in period  $t-1$  – potential GDP growth rate]. The other is  $[\alpha \cdot E_{j,t-1} \Delta \ln Y_t + E_{j,t-1} U_t]$  which is heterogeneous across the forecasters. It is the sum of the  $\alpha \times$  forecaster  $j$ 's GDP growth rate expectations and forecaster  $j$ 's supply shock expectations. The following sections estimate equation (4) by forecaster-level data to derive the anchor of inflation expectations  $\Pi_t^e$  in each period.

## 5. The Estimation Equation

In the following section, we derive the anchor of inflation expectations  $\Pi_t^e$  by using the data of ESP Forecast. In the analysis, we assume that each professional forecaster applies equation (1) when forecasting macroeconomic variables in Japan. We then estimate the following cross-sectional equation:

$$(5) E_{j,\tau} \Pi_{\tau+1} = \text{constant term} + \alpha \cdot E_{j,\tau} \Delta \ln Y_{\tau+1} + \sum_{i=1}^N \beta_{i,t} E_{j,\tau} \Delta \ln X_{\tau}^i + \varepsilon_{j\tau},$$

where  $E_{j,\tau} \Pi_{\tau+1} = j$ 's inflation forecast,  $E_{j,\tau} \Delta \ln Y_{\tau+1} = j$ 's real GDP growth rate forecast, and  $E_{j,\tau} \Delta \ln X_{\tau}^i = j$ 's forecast of supply shocks. The expectation operator  $E_{j,\tau}$  suggests that forecaster  $j$  forms his or her expectation in period  $\tau$  to forecast the value in period  $\tau+1$ .

Equation (5) is the ESP Forecast version of equation (4), where the constant term is the sum of the anchor of inflation expectations and  $\alpha$  [realized GDP gap in period  $t-1$  – potential GDP growth rate].<sup>6</sup> In ESP Forecast, we can observe both  $E_{j,\tau} \Pi_{\tau+1}$  and  $E_{j,\tau} \Delta \ln Y_{\tau+1}$  for several alternative horizons. However, we cannot observe  $E_{j,\tau} \Delta \ln X_{\tau}^i$  directly. We thus use  $j$ 's forecasts of the yen-dollar exchange rate and the NY WTI crude oil futures price for proxies of supply shocks. Since only the forecasted level is available for these variables in ESP Forecast, we constructed their changes by taking logged difference between the forecasted future value and the realized current value.

When estimating equation (5), we use inflation forecasts of after-tax core CPI for  $E_{j,\tau} \Pi_{\tau+1}$ . The sample period of the forecast origin is from June 2011 to March 2018. We start the sample period from June 2011 to exclude discontinuous changes in ESP Forecast caused by

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<sup>6</sup> The constant term can change over time when  $\tau$  changes. But to the extent that  $\tau$  is fixed, it is time invariant in each estimated estimation.

the CPI base year revision. The sample period allows us to see whether there were structural changes in equation (5) after the BOJ introduced the explicit 2% inflation target in January 2013.

As we explained in section 3, ESP Forecast provides a panel of the fixed event forecasts at various horizons. It is, however, worthwhile to note that the quoted forecast monotonically diverges from the long-run anchor point and converges towards actual value as the forecast horizon shortens. In particular, when the value in fiscal year T is forecasted from January to May in year T+1, most of their components have already been realized. Even when the value in fiscal years T is forecasted from June to December in year T, some of their components have already been realized. Thus in the analysis, we exclude these forecasts and focus only on the following four types of forecasts.

The first type (type I) is a set of forecasted values in fiscal year T+2 which are quoted from June to December in year T. They have a desirable property to see anchor of medium-term inflation forecasts in that their forecast horizons are the longest in ESP Forecast. But available forecasted variables are limited to real GDP growth rate and core CPI inflation rate. Thus when calculating the anchor, we cannot remove the effects of supply shocks in the first type.

The second type (type II) is a set of forecasted values in fiscal year T+1 which are quoted from January to May in year T. Their forecast horizons are slightly shorter than those in the first type but longer than the other two types. More importantly the second type includes forecasted values of various macro variables, especially the yen-dollar exchange rate and the oil price. Thus we can calculate the anchor of medium-term inflation forecasts after controlling for the effects of supply shocks in the second type.

The third type (type III) is a set of forecasted values in fiscal year T+1 which are quoted from June to December in year T. Since the third type also includes forecasted values of various macro variables, we can derive the anchor after controlling for the effects of supply shocks. But since their forecast horizons are shorter, the anchor is likely to be that of short-term inflation forecasts.

The fourth type (type IV) is a set of forecasted values in fiscal year T which are quoted from January to May in year T. It also includes forecasted values of various macro variables. Since the forecast horizons are the shortest, forecast errors tend to be the smallest among the four types. We may interpret that the forecast values reflect short-term expectations. They are

likely to have very different features from long-term expectations.

## 6. The Estimation Results

We estimated equation (5) by using panel data of the four alternative types of forecasts. **Table 4** reports the estimation results with and without supply shocks for each type of forecasts. The estimations were implemented either with or without monthly time dummies.

The estimated coefficient of the GDP growth rate forecast was positive in all cases and statistically significant except for type I forecasts in 2014. This implies that ESP Forecast supports our Phillips curve. However, the estimated coefficient tended to be larger when the forecast origin was in the QQE period than when it was in the pre-QQE period. That is, in the pre-QQE period, the estimated coefficient was less than 0.2 in most cases and rarely exceeded 0.3, which implies that the Phillips curve was very flat. In contrast, in the QQE period, the estimated coefficient frequently exceeded 0.4 and rarely fell below 0.2. In particular, it exceeded 0.7 for type II forecasts in 2018. This indicates that the BOJ's unprecedented monetary easing made the inflation forecast more sensitive to the GDP growth forecast and made the slope of our panel Phillips curve steeper.

More importantly, the estimated constant term also changed over time. In the table, the estimated constant term had three features depending on when the forecast origin was. First it was negative in most cases when the forecast origin was before announcing the 2% inflation target. When the forecast origin was in 2011 or 2012, the estimated constant term was always less than -0.15. The negative value was particularly substantial in short-term forecasts (that is, type III and IV forecasts) where it sometimes fell below -0.5. Second it became significantly positive and sometimes took large positive values when the forecast origin was soon after announcing the 2% inflation target. Except for type IV forecasts, the estimated constant term was always positive when the forecast origin was after 2013. In particular, it became large from June 2013 to December 2014 for type III and IV forecasts and from June 2014 to May 2016 for type I and II forecasts. Third it started to decline when the forecast origin was after 2015. For type III and IV forecasts, the estimated constant term sometimes became less significant after 2015. For type I and II forecasts, the estimated constant term always remained statistically significant even after 2015. But its absolute value declined after June

2016.

The above results suggest that the intercept of our panel Phillips curve, which was negative before announcing the 2% target, increased substantially soon after announcing the 2% target. In other words, the Phillips curve shifted upward soon after announcing the 2% target. The BOJ's explicit inflation target could partly anchor inflation expectations. However, the intercept of our panel Phillips curve declined significantly as the QQE progressed. The upward shift did not persist when it turned out that the 2% target would not be feasible in the short-run. This implies that an explicit inflation targeting needs to be a feasible one to shift the Phillips curve upward persistently.

Comparing the results with and without supply shocks, the estimated constant term without supply shocks was always greater than that with supply shocks. This implies that yen's depreciation and oil price increases were one of the reasons why our Phillips curve shifted upward in the QQE period. However, even if we control for the effects of these supply shocks, we can still observe that the constant term increased soon after announcing the 2% inflation target but declined as the QQE progressed. The upward and downward shifts of the Phillips curve occurred even if we controlled the effects of the supply shocks.

Among the four types of forecasts, the constant term for types I and II forecasts tended to be higher than that for the other two types in the QQE period. In particular, it remained higher even if the QQE progressed. The estimated constant term exceeded 1.0 for type I forecasts when the forecast origin was in 2015 and 2016 and 0.8 for type II forecasts when the forecast origin was in 2016. It was only after 2017 when the estimated constant term started to decline. In contrast, the constant term for types III and IV forecasts not only showed modest increases in the QQE period but also started to decline earlier as the QQE progressed. As explained in the last section, forecasts for types I and II forecasts are those with longer time horizons, while forecasts for types III and IV forecasts are those with shorter time horizons. It is likely imply that depending on the length of forecast time horizons, the shifts in the Phillips curve were different in their magnitude and timing.

## 7. The Estimated Anchor of the Inflation Expectation

One of the key features in our expectations-augmented Phillips curve is that the constant

term equals to the sum of  $\Pi_t^e$  and  $\alpha$  [GDP gap in period  $\tau$  – potential GDP growth rate], where  $\tau$  is the period of the forecast origin. This indicates that we can derive the estimated anchor of inflation expectations subtracting  $\hat{\alpha}$  [GDP gap in period  $\tau$  – potential GDP growth rate] from the estimated constant term, where  $\hat{\alpha}$  is the estimated coefficient of the GDP growth rate forecast.

In deriving the anchor of inflation expectations, we used the potential GDP growth rate and GDP gap both of which were estimated by Cabinet Office of Japanese government (September 2018 version). Since no estimated potential growth rate was available in 2018 and 2019, we set potential GDP growth rate in 2018 and 2019 to be 1.0 percent which equals to the estimated rate in 2015 and 2016. For GDP gap, we first took average of the quarterly series from the third quarter in 2013 to the fourth quarter in 2014 to smooth out the effect of consumption tax hikes. We then converted the smoothed quarterly series into semi-annual series through taking their moving averages.<sup>7</sup> Based on the estimated results without monthly time dummies in Table 4, [Figure 2](#) depicts how the derived anchor of inflation expectations changed over time for the four types of forecasts. The figure has three noteworthy features.

First, when the forecast origin was in 2011 and 2012, the derived anchor was negative for types III and IV forecasts and was close to zero for type II forecasts. This implies that inflation expectations had been anchored in non-positive values before the BOJ announced 2% target in January 2013. After the GFC, the CPI inflation rates had been negative in Japan in most of the periods until May 2013. It is likely that the persistent CPI declines occurred not only because recessions had been prolonged but also because non-positive inflation expectations had been anchored persistently.

Second, the derived anchor increased significantly in 2013 and in 2014 and remained positive in the following years. This implies that the announcement of 2% target was successful in anchoring inflation expectations in positive values. Since the previous targeted rate was around 1 percent, the announcement of the 2% target was a dramatic change in the BOJ's commitment. In particular, when introducing the QQE on April 4, 2013, the BOJ made a commitment that it would achieve the CPI price stability target of 2 percent “at the earliest possible time.” It is likely that the dramatic change in the BOJ's policy regime was successful

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<sup>7</sup> Specifically, we calculated the semi-annual series for types I and II by [(2nd quarter gap) + 3\*(3rd quarter gap) + 3\*(4th quarter gap)]/7 and the semi-annual series for types III and IV by [3\*(1st quarter gap) + 2\*(2nd quarter gap)]/5.

in shifting anchor of inflation expectations upward.

Third, despite the upward shift after the announcement of 2% target, the derived anchor never reached 2 percent. It never exceeded 1.5% when we controlled the effects of supply shocks. It exceeded 1.5% in 2015 for type I forecasts and in 2016 for type II forecasts when we did not control the effects of supply shocks. But even in these cases, the increased anchor did not persist. This implies that the announcement of 2% target was not successful in anchoring inflation expectations at the targeted rate. After introducing the QQE, the CPI inflation rate turned into positive in Japan. However, it started to decline in the latter half of 2014. It is likely that the role of the explicit inflation target faced structural changes in anchoring inflation expectations in Japan when it turned out that the 2% target would not be feasible in the short-run.

Comparing the four types of forecasts, the derived anchors in types III and IV not only increased earlier after the 2% target announcement but also started to decline earlier as the QQE progressed. This implies that the short-term anchor of inflation expectations were more sensitive not only to the 2% target announcement but also to the following inflation decline. In contrast, the derived anchors in type I and II forecasts started to increase in larger scale after the anchors in type III and IV forecasts had already increased. The medium-term anchor of inflation expectations showed delayed but larger fluctuations than the short-term anchor after the 2% target announcement. However, even in the medium-term forecasts, the increases in the anchor of inflation expectations did not persist when it turned out that the 2% target would not be feasible in the short-run.

## 8. Robustness I: Instrumental variables

In previous sections, we derived the anchor of inflation expectations through estimating equation (5) by ordinary least squares. But the use of ordinary least squares raises concern about possible simultaneous biases in the estimation. The purpose of this section is to examine whether our results are robust even when estimating equation (5) by instrumental variable method. Specifically, we estimate equation (5) by using one-month lagged values of the GDP growth rate forecasts, the yen-dollar exchange forecasts, and the crude oil futures



price forecasts as instrumental variables to derive anchor of inflation expectations.<sup>8</sup> One problem for using the instrumental variables is that no appropriate lagged value is available when the forecast origin is in January for type II or IV forecasts and in July for type I or III forecasts. This happens because ESP Forecast is a fixed-event forecast where the forecast horizons are different depending on in which month the forecast is quoted. Thus, when using the instrumental variable method, we estimate equation (5) using panel data from February to June for type II and IV forecasts and from August to December for type I and III forecasts.

**Table 5** reports the estimation results with and without supply shocks for the four alternative types of forecasts. As in the previous sections, the estimations were implemented either with or without monthly time dummies. Because of limited availability of instrumental variables, the number of observations became smaller. Compared with those in Table 4, the constant term became insignificant in 2012 for type II forecasts and in 2018 for type IV forecasts. However, most of the estimated coefficients remained statistically significant and were essentially the same as those in table 4 even if we estimated by using the instrumental variables.

The estimated coefficient of the GDP growth rate forecast was positive in all cases but became larger in the QQE period than in the pre-QQE period. More importantly, the estimated constant term which had been negative in most cases, became significantly positive after announcing the 2% target and then started to decline around 2015. This indicates that the BOJ's unprecedented monetary easing shifted our panel Phillips curve upward for a few years but that the upward shift did not persist when it turned out that the 2% target would not be feasible in the short-run.

Based on the estimated results without monthly time dummies in Table 5, we derived the anchor of inflation expectations  $\pi_t^e$  for the four types of forecasts using the same method in section 7. **Figure 3** depicts how the derived anchors of inflation expectations changed over time. Although some slight differences exist, they are essentially the same as those in Figure 2. That is, the derived anchor, which tended to be negative before announcing the 2% target, increased significantly in 2013 and in 2014 and remained positive in the following years. However, despite the upward shift, the derived anchor never reached 2 percent. This implies

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<sup>8</sup> In case of type I forecasts, we use one-month lagged values of the GDP growth rate forecasts as an instrumental variable because the yen-dollar exchange forecasts and the crude oil futures price forecasts are not available.

that the announcement of 2% target was successful in anchoring inflation expectations in positive values but was not successful in anchoring them at the targeted rate.

#### 9. Robustness II: Additional exogenous shocks

Until the last section, we have derived the anchor of inflation expectations using forecasts of the yen-dollar exchange rate and the NY WTI crude oil futures price as supply shocks. We used them because both foreign exchange rates and oil prices have been major sources of supply shocks in the Japanese economy. However, in integrated global production networks, the Japanese economy is increasingly more connected with the rest of the world, especially with the USA and China. The purpose of this section is to examine whether our results are robust even if we estimate equation (5) including forecasted growth rates of the USA and China as additional exogenous shocks. In the estimation, we take the difference between the forecasted and the realized values of the US and China's growth rates respectively to calculate the additional exogenous shocks.

Putting aside including two additional explanatory variables, the estimated equation is the same as those in Table 3. [Table 6](#) reports the estimation results with and without monthly time dummies for types II, III, and IV of forecasts. The additional shocks frequently took significantly positive sign. This implies that accelerated growth in the USA and China had positive spillover effects on the inflation rate in Japan. Compared with those in Table 3, the constant term became insignificant in 2014 for type II forecasts, in 2016 for type III forecasts, and in 2017 for type IV forecasts. However, most of the estimated coefficients remained statistically significant and were essentially the same as those in table 4.

The estimated coefficient of the GDP growth rate forecast was significantly positive in all cases but became larger in the QQE period than in the pre-QQE period. More importantly, the estimated constant term changed over time. It was negative in most cases before announcing the 2% target. However, it became significantly positive after announcing the 2% target and then started to decline around 2016.

Based on the estimated results without monthly time dummies in Table 6, we derived the anchor of inflation expectations for the four types of forecasts using the same method in section 7. [Figure 4](#) depicts how the derived anchors of inflation expectations changed over

time when excluding the effects of the supply shocks and the two exogenous shocks. Compared with those in Figure 2, the derived anchors in the figure were slightly larger and for type II forecasts and slightly smaller for type III and IV forecasts. However, their features are essentially the same as those in Figure 2. The announcement of 2% target was successful in anchoring inflation expectations in positive values but was not successful in anchoring them at the targeted rate.

## 10. Concluding Remarks

In this paper, we explored whether the explicit inflation targeting regime could anchor inflation expectations in Japan. In the analysis, we estimated panel Phillips curves by using Japanese forecaster-level data of “ESP Forecast”. We found significant structural changes in how to form private inflation forecasts. Before the BOJ announced the 2% target, inflation expectations had been anchored in negative values, which caused prolonged deflation after the GFC. But the new target increased anchor of inflation expectations to significant positive values. This implies that the 2% target was successful in overcoming prolonged deflation. However, the estimated anchor has never reached the target. This implies that an explicit inflation target was far from satisfactory to anchor inflation expectations in desirable values.

The Japanese economy is an exceptional country that has been suffering from extremely low inflation since the mid-1990s. To overcome prolonged deflationary mindset, the BOJ announced the 2% inflation target in January 2013 and made a commitment that it would achieve the target “with a time horizon of about two years” in April 2013. But despite the unprecedented monetary easing, the BOJ kept facing a serious difficulty in achieving the target. Fujiki and Tomura (2018) discussed possible scenarios after the BOJ achieves the inflation target. Our empirical results, however, suggest that it is still a long way for the BOJ to anchor inflation expectations in desirable values.

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**Table 1. Timeline of Japan's Unconventional Monetary Policy**

Date	Description		Governor
19-Dec-08	Lowering of the Bank's target for the uncollateralized overnight call rate by 20 basis points; it will be encouraged to remain at around 0.1 percent.		Shirakawa
18-Dec-09	The midpoints of most Policy Board members' "understanding" are around 1 percent CPI inflation rate.		Shirakawa
5-Oct-10	Comprehensive Monetary Easing		Shirakawa
22-Jan-13	The "2% Price Stability Target" under the Framework for the Conduct of Monetary Policy		Shirakawa
4-Apr-13	Introduction of the "Quantitative and Qualitative Monetary Easing (QQE)"	QQE1	Kuroda
31-Oct-14	Expansion of the Quantitative and Qualitative Monetary Easing	QQE2	Kuroda
29-Jan-16	Introduction of "Quantitative and Qualitative Monetary Easing with a Negative Interest Rate"	NIRP1	Kuroda
21-Sep-16	New Framework for Strengthening Monetary Easing: "Quantitative and Qualitative Monetary Easing with Yield Curve Control"	NIRP2	Kuroda

Source: The Bank of Japan.

**Table 2. The BOJ's Point Estimates of Core CPI Inflation Rates**

forecast origin	Estimated fiscal year T									
	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020
April in T-2	NA	NA	NA	NA	1.9	2.1	1.9	1.9	1.9	1.8
July in T-2	NA	NA	NA	NA	1.9	2.1	1.8	1.9	1.8	1.6
Oct. in T-2	-0.4	0.6	0.5	0.8	1.9	2.1	1.8	1.7	1.8	1.5
Jan. in T-1	-0.2	0.6	0.5	0.9	1.9	2.2	1.8	1.7	1.8	NA
April in T-1	0.1	0.7	0.7	1.4	1.9	2	1.7	1.7	1.8	NA
July in T-1	0.1	0.7	0.7	1.3	1.9	1.9	1.7	1.5	1.5	NA
Oct. in T-1	0.1	0.1	0.4	1.3	1.7	1.4	1.5	1.4	1.4	NA
Jan. in T	0.3	0.1	0.4	1.3	1	0.8	1.5	1.4	NA	NA
April in T	0.7	0.3	0.7	1.3	0.8	0.5	1.4	1.3	NA	NA
July in T	0.7	0.2	0.6	1.3	0.7	0.1	1.1	1.1	NA	NA
Oct. in T	0	-0.1	0.7	1.2	0.1	-0.1	0.8	0.9	NA	NA
Jan. in T+1	-0.1	-0.2	0.7	0.9	0.1	-0.2	0.8	NA	NA	NA
April in T+1	0	-0.2	0.8	0.8	0	-0.3	0.7	NA	NA	NA
realized rate	0	-0.2	0.8	0.8	0	-0.2	0.7	NA	NA	NA

Source: Outlook for Economic Activity and Prices, the Bank of Japan.

**Table 3. The Basic Statistics of Forecasted Values**

(1) Real GDP growth rate

		Jan. in T-1	July in T-1	Jan. in T	July in T	Jan. in T+1
FY2010	average	1.21	1.11	1.25	2.47	3.22
	standard deviation	0.52	0.61	0.39	0.33	0.18
FY2011	average	1.65	1.81	1.39	0.17	-0.33
	standard deviation	0.38	0.43	0.33	0.40	0.27
FY2012	average	2.06	2.92	1.89	2.32	0.99
	standard deviation	0.30	0.35	0.43	0.22	0.15
FY2013	average	1.42	1.59	1.61	2.75	2.53
	standard deviation	0.51	0.39	0.43	0.25	0.12
FY2014	average	0.23	0.58	0.84	0.85	-0.60
	standard deviation	0.56	0.48	0.35	0.31	0.15
FY2015	average	1.35	1.35	1.75	1.66	1.05
	standard deviation	0.32	0.28	0.36	0.24	0.11
FY2016	average	1.63	1.73	1.44	0.62	1.21
	standard deviation	0.38	0.30	0.26	0.26	0.10
FY2017	average	0.06	0.84	1.12	1.40	1.88
	standard deviation	0.31	0.30	0.24	0.16	0.11
FY2018	average	1.02	1.10	1.26	NA	NA
	standard deviation	0.36	0.28	0.22	NA	NA
FY2019	average	0.77	NA	NA	NA	NA
	standard deviation	0.25	NA	NA	NA	NA

(2) Core CPI inflation rate

		Jan. in T-1	July in T-1	Jan. in T	July in T	Jan. in T+1
FY2010	average	0.19	-0.51	-0.93	-0.92	-0.85
	standard deviation	0.41	0.43	0.32	0.18	0.08
FY2011	average	-0.31	-0.05	-0.18	0.50	-0.10
	standard deviation	0.32	0.20	0.19	0.22	0.09
FY2012	average	0.14	0.33	-0.20	0.06	-0.15
	standard deviation	0.27	0.29	0.26	0.14	0.07
FY2013	average	0.14	0.20	0.10	0.36	0.72
	standard deviation	0.26	0.21	0.25	0.14	0.09
FY2014	average	2.34	2.71	0.88	1.12	0.95
	standard deviation	0.38	0.32	0.30	0.17	0.08
FY2015	average	0.97	1.79	0.84	0.33	0.11
	standard deviation	0.41	0.38	0.33	0.22	0.07
FY2016	average	1.27	1.22	0.82	0.03	-0.25
	standard deviation	0.48	0.41	0.33	0.24	0.06
FY2017	average	1.13	0.72	0.77	0.70	0.66
	standard deviation	0.35	0.42	0.24	0.15	0.08
FY2018	average	0.99	0.89	0.88	NA	NA
	standard deviation	0.35	0.31	0.28	NA	NA
FY2019	average	0.90	NA	NA	NA	NA
	standard deviation	0.40	NA	NA	NA	NA



**Table 4. Basic Estimation Results**

(1-a). Without supply shocks: Type I

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2013 06-12	0.287*** (0.0638)	0.527*** (0.0523)	289	0.253	NO
	0.287*** (0.0646)	0.527*** (0.0529)	289	0.257	YES
2014 06-12	1.094*** (0.151)	0.164 (0.110)	289	0.019	NO
	1.103*** (0.165)	0.157 (0.120)	289	0.020	YES
2015 06-12	1.227*** (0.0253)	0.205*** (0.0755)	268	0.044	NO
	1.229*** (0.0259)	0.199** (0.0767)	268	0.054	YES
2016 06-12	0.344*** (0.0429)	0.644*** (0.0413)	285	0.452	NO
	0.344*** (0.0437)	0.643*** (0.0421)	285	0.455	YES
2017 06-12	0.678*** (0.0843)	0.450*** (0.110)	263	0.093	NO
	0.675*** (0.0844)	0.455*** (0.111)	263	0.100	YES

**Table 4. Basic Estimation Results (continued)**

(1-b). Without supply shocks: Type II

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.239*** (0.0796)	0.250*** (0.0549)	210	0.164	NO
	-0.245*** (0.0791)	0.253*** (0.0547)	210	0.188	YES
2013 01-05	0.410*** (0.0294)	0.194*** (0.0501)	209	0.083	NO
	0.414*** (0.0286)	0.178*** (0.0489)	209	0.127	YES
2014 01-05	0.304*** (0.0910)	0.524*** (0.0668)	215	0.219	NO
	0.301*** (0.0913)	0.526*** (0.0671)	215	0.225	YES
2015 01-05	0.655*** (0.188)	0.353*** (0.105)	215	0.085	NO
	0.639*** (0.188)	0.363*** (0.105)	215	0.092	YES
2016 01-05	0.955*** (0.0247)	0.535*** (0.0884)	215	0.223	NO
	0.961*** (0.0240)	0.518*** (0.0849)	215	0.281	YES
2017 01-05	0.426*** (0.0696)	0.538*** (0.0647)	207	0.310	NO
	0.423*** (0.0700)	0.541*** (0.0651)	207	0.312	YES
2018 01-03	0.345*** (0.101)	0.729*** (0.134)	119	0.229	NO
	0.345*** (0.102)	0.729*** (0.137)	119	0.229	YES

**Table 4. Basic Estimation Results (continued)**

(1-c). Without supply shocks: Type III

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2011 06-12	-1.054*** (0.0805)	0.233*** (0.0323)	316	0.378	NO
	-0.562*** (0.107)	0.237*** (0.0425)	316	0.538	YES
2012 06-12	-0.273*** (0.0476)	0.273*** (0.0298)	306	0.226	NO
	-0.271*** (0.0509)	0.271*** (0.0318)	306	0.253	YES
2013 06-12	0.501*** (0.0334)	0.406*** (0.0624)	311	0.205	NO
	0.492*** (0.0367)	0.419*** (0.0689)	311	0.213	YES
2014 06-12	0.456*** (0.0877)	0.478*** (0.0615)	319	0.207	NO
	0.328*** (0.0890)	0.569*** (0.0610)	319	0.262	YES
2015 06-12	0.178** (0.0823)	0.603*** (0.0731)	311	0.205	NO
	0.186 (0.134)	0.538*** (0.0781)	311	0.239	YES
2016 06-12	0.267*** (0.0619)	0.452*** (0.0626)	317	0.182	NO
	0.245*** (0.0604)	0.476*** (0.0622)	317	0.239	YES
2017 06-12	0.302*** (0.0837)	0.488*** (0.0779)	291	0.179	NO
	0.272*** (0.0836)	0.514*** (0.0776)	291	0.206	YES

**Table 4. Basic Estimation Results (continued)**

(1-d). Without supply shocks: Type IV

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.668*** (0.0933)	0.182*** (0.0479)	218	0.171	NO
	-0.492*** (0.0944)	0.193*** (0.0488)	218	0.328	YES
2013 01-05	-0.192** (0.0790)	0.197*** (0.0378)	216	0.131	NO
	-0.0821 (0.113)	0.144*** (0.0547)	216	0.147	YES
2014 01-05	0.803*** (0.0442)	0.185*** (0.0623)	224	0.060	NO
	0.786*** (0.0447)	0.207*** (0.0632)	224	0.098	YES
2015 01-05	0.151* (0.0801)	0.200** (0.0826)	224	0.032	NO
	0.183 (0.124)	0.182** (0.0718)	224	0.313	YES
2016 01-05	-0.230*** (0.0847)	0.557*** (0.0745)	225	0.286	NO
	0.0696 (0.0911)	0.291*** (0.0801)	225	0.432	YES
2017 01-05	0.403*** (0.0799)	0.330*** (0.0641)	216	0.141	NO
	0.369*** (0.0903)	0.357*** (0.0724)	216	0.155	YES
2018 01-03	0.271* (0.151)	0.509*** (0.122)	122	0.204	NO
	0.276* (0.156)	0.505*** (0.126)	122	0.213	YES

**Table 4. Basic Estimation Results (continued)**

(2-a). Without supply shocks: Type II

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.155** (0.0740)	0.202*** (0.0595)	0.124 (0.438)	-0.0438 (0.615)	158	0.123	NO
	-0.158* (0.0933)	0.203*** (0.0592)	0.156 (0.431)	-0.0243 (0.642)	158	0.142	YES
2013 01-05	0.395*** (0.0340)	0.184*** (0.0488)	0.286 (0.517)	0.121 (0.897)	163	0.087	NO
	0.404*** (0.0351)	0.171*** (0.0478)	0.221 (0.512)	-0.0930 (0.889)	163	0.118	YES
2014 01-05	0.243*** (0.0853)	0.488*** (0.0640)	2.197*** (0.591)	2.962** (1.186)	162	0.365	NO
	0.240*** (0.0873)	0.492*** (0.0651)	4.300*** (0.595)	2.772** (1.172)	162	0.380	YES
2015 01-05	0.411** (0.192)	0.335*** (0.108)	1.869*** (0.579)	2.319 (1.777)	167	0.154	NO
	0.382** (0.182)	0.346*** (0.106)	1.994*** (0.564)	2.210 (1.735)	167	0.161	YES
2016 01-05	0.777*** (0.0727)	0.428*** (0.0993)	1.161*** (0.420)	-0.903 (1.055)	169	0.238	NO
	0.746*** (0.0718)	0.401*** (0.0967)	1.331*** (0.431)	0.115 (1.088)	169	0.301	YES
2017 01-05	0.430*** (0.0753)	0.476*** (0.0777)	0.976*** (0.336)	-1.462 (0.945)	188	0.353	NO
	0.429*** (0.0760)	0.477*** (0.0789)	0.982*** (0.343)	-1.439** (0.651)	188	0.354	YES
2018 01-03	0.342*** (0.0933)	0.732*** (0.124)	1.685*** (0.529)	1.835 (1.311)	114	0.361	NO
	0.342*** (0.0937)	0.731*** (0.125)	1.764*** (0.544)	1.647 (1.334)	114	0.367	YES

**Table 4. Basic Estimation Results (continued)**

(2-b). Without supply shocks: Type III

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	# of obs.	R-squared	Horizon dummies
2011 06-12	-0.964*** (0.0937)	0.293*** (0.0388)	0.852** (0.373)	0.970 (0.588)	239	0.390	NO
	-0.577*** (0.128)	0.244*** (0.0510)	0.436 (0.332)	0.437 (0.544)	239	0.494	YES
2012 06-12	-0.179*** (0.0584)	0.238*** (0.0363)	0.833*** (0.191)	-1.72 (1.448)	232	0.258	NO
	-0.168*** (0.0623)	0.229*** (0.0385)	0.843*** (0.209)	-1.677*** (0.461)	232	0.294	YES
2013 06-12	0.386*** (0.0473)	0.432*** (0.0726)	1.472*** (0.491)	1.932*** (0.723)	238	0.223	NO
	0.377*** (0.0505)	0.447*** (0.0807)	1.367** (0.531)	1.956*** (0.741)	238	0.232	YES
2014 06-12	0.455*** (0.102)	0.470*** (0.0712)	1.834*** (0.336)	1.799** (0.808)	240	0.276	NO
	0.436*** (0.111)	0.485*** (0.0759)	1.833*** (0.471)	1.713** (0.829)	240	0.284	YES
2015 06-12	0.271** (0.118)	0.454*** (0.0747)	0.879*** (0.332)	-1.026 (1.182)	257	0.177	NO
	0.345** (0.135)	0.422*** (0.0798)	0.585 (0.363)	-0.838 (1.190)	257	0.192	YES
2016 06-12	0.162** (0.0710)	0.332*** (0.0664)	1.110*** (0.262)	2.659*** (0.637)	261	0.247	NO
	0.106 (0.0728)	0.366*** (0.0640)	1.198*** (0.258)	3.224*** (0.750)	261	0.307	YES
2017 06-12	0.275*** (0.0898)	0.401*** (0.0884)	2.171*** (0.321)	1.505*** (0.519)	285	0.338	NO
	0.241*** (0.0901)	0.424*** (0.0878)	2.308*** (0.321)	1.591*** (0.526)	285	0.370	YES

**Table 4. Basic Estimation Results (continued)**

(2-c). Without supply shocks: Type IV

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.604*** (0.119)	0.127*** (0.0649)	0.823*** (0.216)	1.730** (0.707)	196	0.325	NO
	-0.513*** (0.116)	0.187*** (0.0633)	0.577** (0.226)	1.358* (0.729)	196	0.379	YES
2013 01-05	-0.197** (0.0896)	0.144*** (0.0549)	0.765*** (0.249)	0.802** (0.359)	198	0.228	NO
	-0.193 (0.118)	0.142** (0.0600)	0.763*** (0.262)	0.806 (0.502)	198	0.230	YES
2014 01-05	0.733*** (0.0553)	0.143** (0.0684)	0.584 (0.385)	2.014*** (0.660)	202	0.104	NO
	0.707*** (0.0560)	0.167** (0.0696)	0.607 (0.393)	2.146*** (0.657)	202	0.153	YES
2015 01-05	0.454*** (0.149)	0.184*** (0.0656)	1.752*** (0.199)	1.067 (0.963)	207	0.345	NO
	0.674*** (0.167)	0.148** (0.0636)	1.462*** (0.238)	0.549 (0.872)	207	0.452	YES
2016 01-05	0.343*** (0.105)	0.206*** (0.0775)	0.874*** (0.192)	2.387*** (0.500)	214	0.440	NO
	0.315*** (0.108)	0.177** (0.0781)	0.708*** (0.246)	0.746 (0.737)	214	0.473	YES
2017 01-05	0.266*** (0.0980)	0.313*** (0.0622)	0.952*** (0.338)	0.980** (0.421)	214	0.210	NO
	0.240** (0.106)	0.338*** (0.0692)	0.941*** (0.340)	0.887** (0.413)	214	0.217	YES
2018 01-03	0.125*** (0.0601)	0.548*** (0.128)	0.868*** (0.304)	0.732 (0.700)	122	0.270	NO
	0.128 (0.163)	0.552*** (0.131)	0.736** (0.321)	1.103 (0.749)	122	0.273	YES

Note 1) Robust standard errors in parentheses.

2) \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Table 5. Estimation Results with Instrumental Variables**

(1-a). Without supply shocks: Type I

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2013 06-12	0.250*** (0.0768)	0.555*** (0.0623)	243	0.257	NO
	0.250*** (0.0768)	0.555*** (0.0623)	243	0.261	YES
2014 06-12	1.043*** (0.209)	0.198 (0.154)	244	0.024	NO
	1.041*** (0.203)	0.200 (0.150)	244	0.025	YES
2015 06-12	1.220*** (0.0268)	0.215** (0.0845)	225	0.053	NO
	1.221*** (0.0268)	0.211** (0.0848)	225	0.063	YES
2016 06-12	0.274*** (0.0494)	0.714*** (0.0474)	236	0.473	NO
	0.274*** (0.0498)	0.715*** (0.0474)	236	0.475	YES
2017 06-12	0.652*** (0.101)	0.492*** (0.137)	220	0.102	NO
	0.654*** (0.0997)	0.489*** (0.136)	220	0.108	YES



**Table 5. Estimation Results with Instrumental Variables (continued)**

(1-b). Without supply shocks: Type II

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.236*	0.257***	122	0.134	NO
	(0.129)	(0.0890)			
	-0.227*	0.249***	122	0.157	YES
	(0.129)	(0.0891)			
2013 01-05	0.461***	0.156***	128	0.096	NO
	(0.0219)	(0.0460)			
	0.463***	0.150***	128	0.106	YES
	(0.0221)	(0.0464)			
2014 01-05	0.345***	0.512***	128	0.237	NO
	(0.112)	(0.0821)			
	0.344***	0.511***	128	0.242	YES
	(0.111)	(0.0812)			
2015 01-05	0.609**	0.364***	132	0.084	NO
	(0.243)	(0.136)			
	0.602**	0.369***	132	0.085	YES
	(0.242)	(0.136)			
2016 01-05	0.921***	0.481***	133	0.146	NO
	(0.0327)	(0.130)			
	0.927***	0.456***	133	0.193	YES
	(0.0321)	(0.126)			
2017 01-05	0.303***	0.639***	146	0.324	NO
	(0.0963)	(0.0851)			
	0.304***	0.639***	146	0.325	YES
	(0.0959)	(0.0848)			
2018 01-03	0.284**	0.807***	74	0.233	NO
	(0.120)	(0.161)			
	0.283**	0.809***	74	0.234	YES

**Table 5. Estimation Results with Instrumental Variables (continued)**

(1-c). Without supply shocks: Type III

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2011 06-12	-0.911*** (0.107)	0.369*** (0.0452)	202	0.389	NO
	-0.690*** (0.146)	0.279*** (0.0605)	202	0.487	YES
2012 06-12	-0.261*** (0.0885)	0.263*** (0.0562)	200	0.137	NO
	-0.267*** (0.0919)	0.267*** (0.0584)	200	0.156	YES
2013 06-12	0.494*** (0.0502)	0.416*** (0.0893)	201	0.177	NO
	0.481*** (0.0539)	0.434*** (0.0948)	201	0.190	YES
2014 06-12	0.310** (0.139)	0.585*** (0.0987)	204	0.120	NO
	0.223* (0.135)	0.650*** (0.0948)	204	0.185	YES
2015 06-12	0.178 (0.146)	0.535*** (0.0852)	219	0.159	NO
	0.262* (0.152)	0.483*** (0.0883)	219	0.188	YES
2016 06-12	0.185** (0.0838)	0.503*** (0.0873)	219	0.175	NO
	0.173** (0.0791)	0.518*** (0.0826)	219	0.217	YES
2017 06-12	0.222** (0.101)	0.546*** (0.0918)	242	0.175	NO
	0.207** (0.100)	0.558*** (0.0912)	242	0.191	YES

**Table 5. Estimation Results with Instrumental Variables (continued)**

(1-d). Without supply shocks: Type IV

	Constant term	Real GDP growth	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.806*** (0.165)	0.365*** (0.0836)	154	0.086	NO
	-0.576*** (0.157)	0.249*** (0.0809)	154	0.285	YES
2013 01-05	-0.305** (0.153)	0.255*** (0.0689)	156	0.098	NO
	-0.206 (0.200)	0.210** (0.0892)	156	0.112	YES
2014 01-05	0.797*** (0.0560)	0.216*** (0.0795)	161	0.055	NO
	0.784*** (0.0555)	0.232*** (0.0790)	161	0.078	YES
2015 01-05	-0.274* (0.160)	0.394*** (0.0952)	165	0.064	NO
	-0.180 (0.150)	0.342*** (0.0887)	165	0.148	YES
2016 01-05	-0.158* (0.0951)	0.447*** (0.0902)	166	0.182	NO
	-0.00505 (0.102)	0.302*** (0.0970)	166	0.248	YES
2017 01-05	0.351*** (0.112)	0.372*** (0.0872)	166	0.077	NO
	0.294** (0.122)	0.416*** (0.0944)	166	0.084	YES
2018 01-03	0.291 (0.198)	0.505*** (0.159)	80	0.270	NO
	0.293 (0.198)	0.504*** (0.160)	80	0.270	YES

**Table 5. Estimation Results with Instrumental Variables (continued)**

(2-a). Without supply shocks: Type II

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.186 (0.132)	0.222*** (0.0859)	0.466 (0.509)	0.0314 (0.711)	120	0.146	NO
	-0.185 (0.131)	0.218** (0.0855)	0.520 (0.490)	0.0568 (0.722)	120	0.166	YES
2013 01-05	0.428*** (0.0343)	0.162*** (0.0462)	-0.0230 (0.524)	1.494* (0.844)	128	0.117	NO
	0.432*** (0.0346)	0.157*** (0.0464)	-0.0401 (0.525)	1.402* (0.846)	128	0.124	YES
2014 01-05	0.250*** (0.0932)	0.498*** (0.0702)	4.158*** (0.620)	2.805** (1.288)	126	0.394	NO
	0.248*** (0.0929)	0.498*** (0.0695)	4.236*** (0.612)	2.767** (1.258)	126	0.403	YES
2015 01-05	0.402*** (0.168)	0.407*** (0.108)	2.069*** (0.638)	2.664 (1.797)	131	0.195	NO
	0.401*** (0.167)	0.408*** (0.108)	2.067*** (0.639)	2.648 (1.780)	131	0.195	YES
2016 01-05	0.672*** (0.0884)	0.380*** (0.130)	1.541*** (0.498)	0.108 (1.168)	127	0.223	NO
	0.687*** (0.0846)	0.362*** (0.127)	1.433*** (0.491)	0.579 (1.172)	127	0.259	YES
2017 01-05	0.366*** (0.0959)	0.526*** (0.100)	1.104*** (0.423)	-1.259* (0.655)	145	0.370	NO
	0.367*** (0.0955)	0.525*** (0.0999)	1.109*** (0.427)	-1.255* (0.657)	145	0.371	YES
2018 01-03	0.293** (0.118)	0.819*** (0.158)	1.589*** (0.564)	0.588 (1.782)	73	0.342	NO
	0.292** (0.117)	0.821*** (0.157)	1.592*** (0.571)	0.568 (1.756)	73	0.342	YES

**Table 5. Estimation Results with Instrumental Variables (continued)**

(2-b). Without supply shocks: Type III

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	# of obs.	R-squared	Horizon dummies
2011 06-12	-0.964*** (0.0996)	0.386*** (0.0442)	0.779* (0.436)	0.649 (0.607)	196	0.418	NO
	-0.766*** (0.142)	0.310*** (0.0591)	0.522 (0.391)	0.197 (0.544)	196	0.490	YES
2012 06-12	-0.186** (0.0767)	0.230*** (0.0467)	0.916*** (0.221)	1.492*** (0.479)	197	0.227	NO
	-0.196** (0.0787)	0.236*** (0.0478)	0.923*** (0.223)	1.479*** (0.472)	197	0.246	YES
2013 06-12	0.352*** (0.0617)	0.462*** (0.0936)	1.721*** (0.552)	2.183*** (0.746)	198	0.233	NO
	0.342*** (0.0653)	0.481*** (0.101)	1.567*** (0.586)	2.186*** (0.778)	198	0.245	YES
2014 06-12	0.269** (0.137)	0.610*** (0.0954)	1.848*** (0.373)	1.623 (0.988)	199	0.234	NO
	0.206 (0.147)	0.638*** (0.0956)	1.536*** (0.528)	1.933* (1.027)	199	0.243	YES
2015 06-12	0.233* (0.128)	0.482*** (0.0813)	0.731** (0.346)	-1.581 (1.115)	218	0.185	NO
	0.286** (0.138)	0.458*** (0.0834)	0.493 (0.363)	-1.380 (1.113)	218	0.199	YES
2016 06-12	0.101 (0.0842)	0.388*** (0.0832)	1.032*** (0.292)	2.443*** (0.661)	219	0.258	NO
	0.0459 (0.0841)	0.411*** (0.0761)	1.171*** (0.287)	3.166*** (0.801)	219	0.309	YES
2017 06-12	0.228** (0.102)	0.438*** (0.0986)	2.033*** (0.334)	1.705*** (0.565)	242	0.335	NO
	0.204** (0.100)	0.450*** (0.0961)	2.220*** (0.333)	1.809*** (0.568)	242	0.364	YES

**Table 5. Estimation Results with Instrumental Variables (continued)**

(2-c). Without supply shocks: Type IV

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.710*** (0.199)	0.279*** (0.106)	1.059*** (0.254)	1.387 (0.844)	151	0.263	NO
	-0.581*** (0.186)	0.223** (0.0991)	0.801*** (0.260)	1.014 (0.829)	151	0.345	YES
2013 01-05	-0.313** (0.160)	0.215** (0.0840)	0.754*** (0.274)	0.480 (0.470)	156	0.145	NO
	-0.264 (0.203)	0.196** (0.0929)	0.760*** (0.284)	0.405 (0.611)	156	0.150	YES
2014 01-05	0.730*** (0.0671)	0.169** (0.0853)	0.428 (0.441)	2.112*** (0.761)	160	0.106	NO
	0.712*** (0.0660)	0.193** (0.0850)	0.324 (0.440)	2.107*** (0.735)	160	0.129	YES
2015 01-05	0.224 (0.235)	0.305*** (0.0846)	1.106*** (0.284)	0.686 (1.214)	163	0.203	NO
	0.462* (0.245)	0.219*** (0.0821)	1.316*** (0.266)	0.609 (1.052)	163	0.318	YES
2016 01-05	0.282** (0.137)	0.234** (0.0958)	0.762*** (0.220)	2.148*** (0.601)	162	0.313	NO
	0.359** (0.140)	0.164* (0.0969)	0.968*** (0.262)	1.268* (0.719)	162	0.351	YES
2017 01-05	0.183 (0.131)	0.359*** (0.0827)	1.248*** (0.366)	0.837* (0.482)	166	0.181	NO
	0.148 (0.136)	0.392*** (0.0875)	1.252*** (0.363)	0.713 (0.469)	166	0.182	YES
2018 01-03	0.152 (0.203)	0.547*** (0.163)	0.696* (0.377)	0.737 (0.872)	80	0.326	NO
	0.156 (0.203)	0.547*** (0.164)	0.653* (0.367)	0.906 (0.849)	80	0.329	YES

Note 1) Robust standard errors in parentheses.

2) \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Table 6. Estimation Results with Additional Exogenous Shocks**

(a). Without supply shocks: Type II

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	US GDP growth	China GDP growth	# of obs.	R-squared	Horizon dummies
2012 01-05	-0.217** (0.105)	0.194*** (0.0565)	-0.393 (0.393)	-0.508 (0.572)	0.202*** (0.0429)	0.0461 (0.0582)	156	0.229	NO
	-0.213** (0.105)	0.197*** (0.0565)	-0.369 (0.380)	-0.513 (0.597)	0.199*** (0.0436)	0.0547 (0.0587)	156	0.249	YES
2013 01-05	0.349*** (0.0434)	0.176*** (0.0521)	0.318 (0.591)	0.0332 (0.873)	0.110 (0.0692)	0.0169 (0.107)	162	0.102	NO
	0.353*** (0.0433)	0.167*** (0.0497)	0.160 (0.609)	-0.244 (0.873)	0.116* (0.0699)	0.0506 (0.112)	162	0.134	YES
2014 01-05	-0.0270 (0.167)	0.501*** (0.0681)	4.627*** (0.674)	4.072*** (1.158)	0.156 (0.108)	-0.106 (0.0704)	159	0.413	NO
	-0.00941 (0.171)	0.503*** (0.0691)	4.665*** (0.694)	3.875*** (1.145)	0.143 (0.111)	-0.0988 (0.0724)	159	0.420	YES
2015 01-05	0.406* (0.244)	0.323*** (0.110)	1.874*** (0.611)	1.919 (1.801)	0.248 (0.164)	0.108 (0.138)	165	0.168	NO
	0.357 (0.236)	0.337*** (0.107)	2.002*** (0.596)	1.922 (1.781)	0.239 (0.170)	0.0819 (0.159)	165	0.173	YES
2016 01-05	1.101*** (0.109)	0.389*** (0.0906)	0.958** (0.416)	-0.920 (1.075)	0.0780 (0.111)	0.458*** (0.104)	168	0.331	NO
	1.027*** (0.112)	0.378*** (0.0902)	1.109** (0.439)	-0.173 (1.098)	0.0312 (0.108)	0.414*** (0.103)	168	0.374	YES
2017 01-05	0.338** (0.144)	0.473*** (0.0866)	0.920*** (0.330)	-1.192 (0.773)	0.133* (0.0691)	0.0788 (0.136)	183	0.372	NO
	0.339** (0.147)	0.474*** (0.0876)	0.923*** (0.335)	-1.167 (0.780)	0.135* (0.0710)	0.0852 (0.137)	183	0.373	YES
2018 01-03	0.681*** (0.157)	0.745*** (0.127)	1.644*** (0.570)	3.933*** (1.158)	-0.257*** (0.0750)	0.590*** (0.197)	109	0.476	NO
	0.674*** (0.157)	0.745*** (0.128)	1.676*** (0.570)	3.826*** (1.155)	-0.257*** (0.0790)	0.580*** (0.202)	109	0.477	YES

**Table 6. Estimation Results with Additional Exogenous Shocks (continued)**

(b). Without supply shocks: Type III

	Constant term	Real GDP growth	NY WTI oil price	USD/Yen rate	US GDP growth	China GDP growth	# of obs.	R-squared	Horizon dummies
2011 06-12	-0.975*** (0.128)	0.367*** (0.0590)	0.787** (0.385)	0.780 (0.589)	0.0867 (0.0595)	-0.0324 (0.0331)	238	0.401	NO
	-0.633*** (0.142)	0.276*** (0.0602)	0.416 (0.330)	0.607 (0.582)	-0.0466 (0.0576)	-0.0371 (0.0303)	238	0.499	YES
2012 06-12	-0.173** (0.0680)	0.230*** (0.0368)	0.717*** (0.201)	-1.867*** (0.455)	0.0747 (0.0485)	0.0698* (0.0416)	230	0.316	NO
	-0.177** (0.0724)	0.235*** (0.0385)	0.755*** (0.211)	-1.794*** (0.465)	0.0631 (0.0491)	0.0487 (0.0427)	230	0.330	YES
2013 06-12	0.219*** (0.0700)	0.436*** (0.0700)	1.456*** (0.476)	2.571*** (0.673)	0.184*** (0.0588)	0.0537 (0.0638)	237	0.255	NO
	0.219*** (0.0728)	0.448*** (0.0762)	1.379*** (0.505)	2.553*** (0.666)	0.179*** (0.0617)	0.0569 (0.0795)	237	0.261	YES
2014 06-12	0.399*** (0.118)	0.457*** (0.0714)	1.913*** (0.358)	2.059** (0.808)	0.136 (0.103)	0.00761 (0.0963)	240	0.284	NO
	0.380*** (0.126)	0.472*** (0.0767)	1.899*** (0.491)	1.987** (0.834)	0.133 (0.105)	0.00934 (0.0969)	240	0.293	YES
2015 06-12	0.513*** (0.135)	0.380*** (0.0746)	0.724** (0.316)	-0.987 (1.189)	0.189 (0.128)	0.311*** (0.111)	256	0.222	NO
	0.529*** (0.142)	0.372*** (0.0782)	0.572 (0.356)	-0.891 (1.208)	0.165 (0.135)	0.296*** (0.111)	256	0.229	YES
2016 06-12	0.117 (0.0846)	0.177*** (0.0621)	1.317*** (0.257)	2.720*** (0.668)	0.358*** (0.0932)	0.170** (0.0736)	254	0.337	NO
	0.0644 (0.0830)	0.221*** (0.0605)	1.447*** (0.245)	3.631*** (0.752)	0.317*** (0.0842)	0.164** (0.0728)	254	0.394	YES
2017 06-12	0.418*** (0.118)	0.322*** (0.0716)	2.276*** (0.327)	1.282** (0.543)	0.203** (0.0946)	0.191 (0.138)	278	0.360	NO
	0.487*** (0.117)	0.322*** (0.0697)	2.503*** (0.330)	1.256** (0.559)	0.164* (0.0914)	0.326** (0.140)	278	0.403	YES



**Table 6. Estimation Results with Additional Exogenous Shocks (continued)**

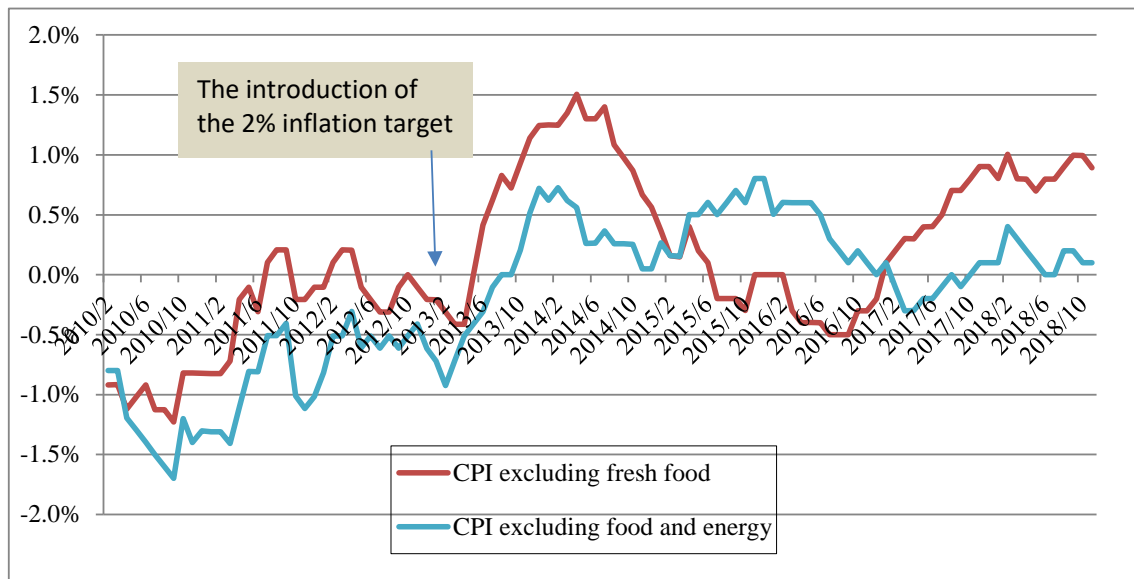
(c). Without supply shocks: Type IV

	Constant	Real GDP	NY WTI	USD/Yen	US GDP	China GDP	# of obs.	R-squared	Horizon
	term	growth	oil price	rate	growth	growth			dummies
2012 01-05	-0.590*** (0.143)	0.225*** (0.0683)	0.836*** (0.217)	1.773** (0.709)	-0.0269 (0.0836)	-0.00554 (0.0484)	194	0.325	NO
	-0.460*** (0.140)	0.178*** (0.0684)	0.624*** (0.237)	1.406* (0.729)	-0.0200 (0.0847)	0.0283 (0.0510)	194	0.380	YES
2013 01-05	-0.157* (0.0831)	0.135*** (0.0510)	0.574** (0.236)	0.889*** (0.330)	0.162*** (0.0531)	0.141** (0.0614)	197	0.284	NO
	-0.152 (0.109)	0.135** (0.0543)	0.598** (0.248)	0.818* (0.459)	0.165*** (0.0540)	0.153** (0.0639)	197	0.288	YES
2014 01-05	0.649*** (0.107)	0.139** (0.0669)	0.556 (0.391)	1.855*** (0.650)	0.157* (0.0828)	0.128 (0.105)	199	0.167	NO
	0.611*** (0.109)	0.163** (0.0676)	0.488 (0.402)	1.940*** (0.644)	0.181** (0.0826)	0.148 (0.105)	199	0.220	YES
2015 01-05	0.806*** (0.150)	0.131* (0.0689)	1.642*** (0.191)	0.0224 (0.963)	0.228*** (0.0711)	0.360*** (0.129)	207	0.391	NO
	0.758*** (0.169)	0.140** (0.0649)	1.400*** (0.236)	0.174 (0.880)	0.0334 (0.0938)	0.234** (0.116)	207	0.461	YES
2016 01-05	0.612*** (0.140)	0.120 (0.0791)	0.890*** (0.184)	2.411*** (0.543)	0.0455 (0.0965)	0.387*** (0.0996)	213	0.479	NO
	0.480*** (0.141)	0.135* (0.0803)	0.737*** (0.232)	0.956 (0.640)	-0.0510 (0.0893)	0.395*** (0.0955)	213	0.508	YES
2017 01-05	0.114 (0.126)	0.310*** (0.0724)	0.846*** (0.316)	0.617 (0.469)	0.244*** (0.0720)	-0.0489 (0.106)	209	0.253	NO
	0.114 (0.129)	0.308*** (0.0769)	0.827** (0.321)	0.614 (0.466)	0.248*** (0.0803)	-0.0533 (0.108)	209	0.254	YES
2018 01-03	0.493** (0.235)	0.413*** (0.124)	0.698** (0.294)	0.375 (0.760)	0.112 (0.130)	0.535** (0.224)	119	0.346	NO
	0.510** (0.235)	0.401*** (0.121)	0.817*** (0.280)	-0.00519 (0.802)	0.120 (0.134)	0.564** (0.228)	119	0.349	YES

Note 1) Robust standard errors in parentheses.

2) \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Figure 1. The CPI inflation Rate in Japan**

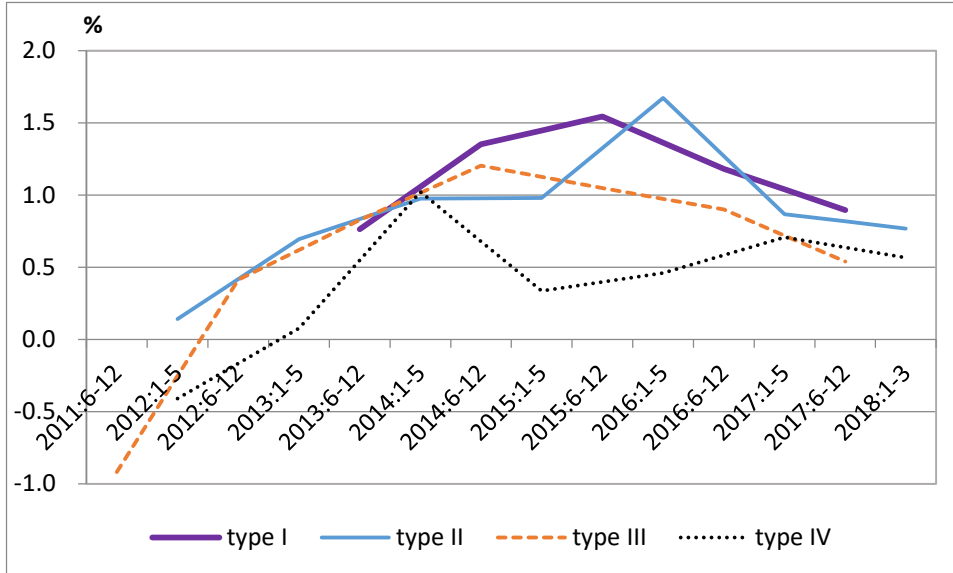


Note: The direct effects of consumption tax hikes are excluded in the inflation rates.

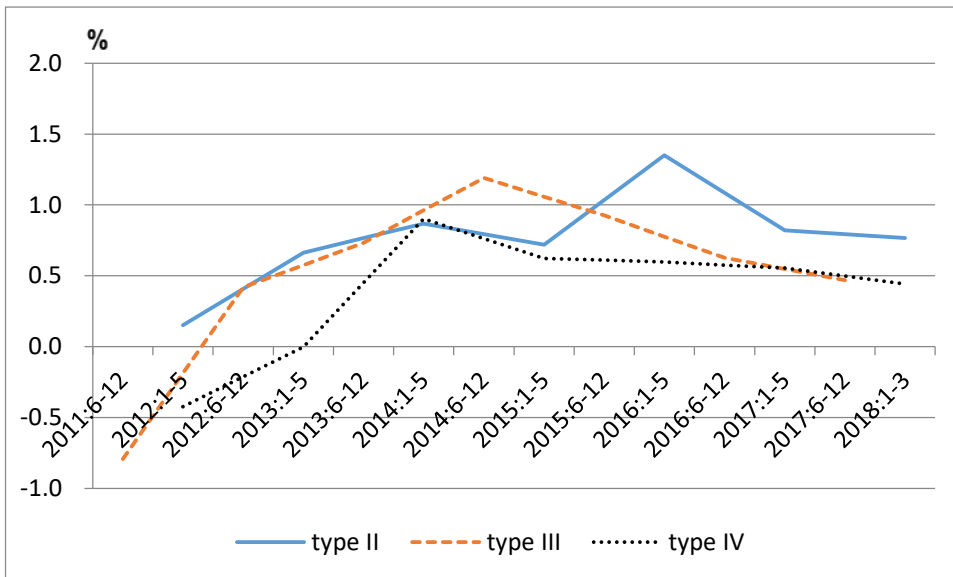
Source: Consumer Price Index, Statistics Bureau, Ministry of Internal Affairs and Communications.

**Figure 2. Estimated Anchor of Inflation Expectations: Basic Results**

(1) Without controlling supply shocks



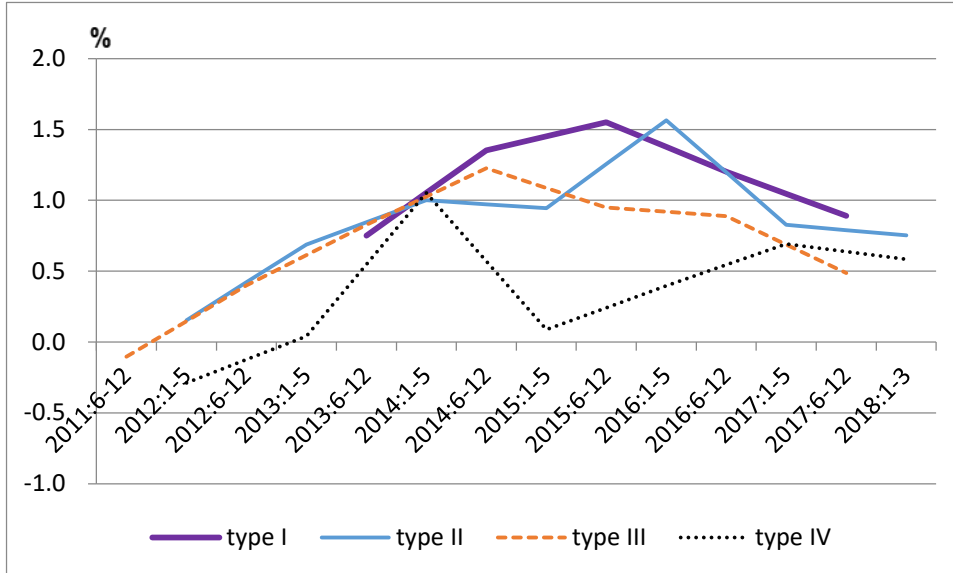
(2) With controlling supply shocks



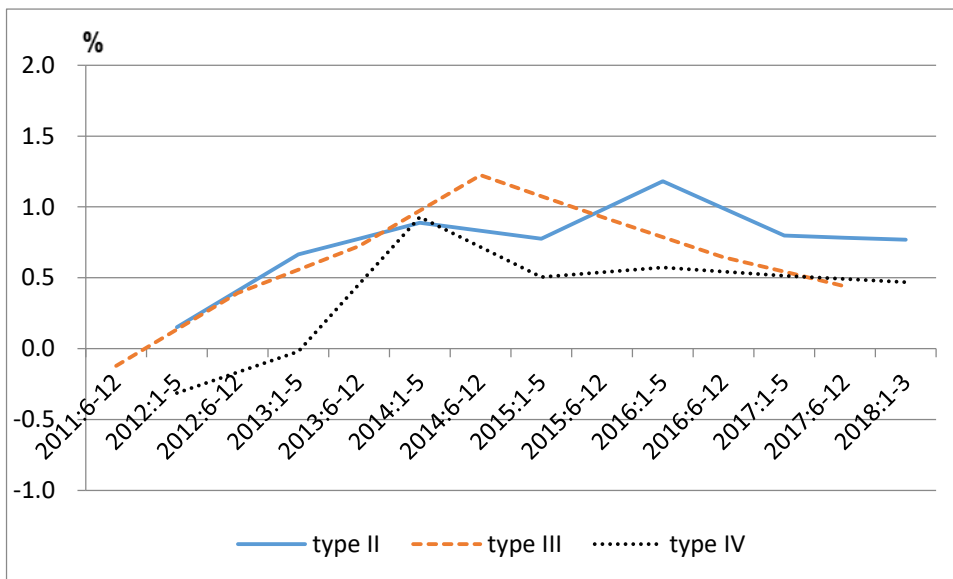
Note: The vertical axis is the estimated anchor of inflation expectations.

**Figure 3. Anchor of Inflation Expectations: With Instrumental Variables**

(1) Without controlling supply shocks



(2) With controlling supply shocks



Note: The vertical axis is the estimated anchor of inflation expectations.

**Figure 4. Anchor of Inflation Expectations: With Additional Exogenous Variables**

