Does Expected Inflation Matter? Evidence from Value-Added Tax Hikes in Japan

Yuta Takahashi and Naoki Takayama*
Institute of Economic Research, Hitotsubashi University

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Abstract

New Keynesian models assign a key role to expected inflation, forming the basis for both the theoretical potency of fiscal policy at the zero lower bound of nominal interest rate and counterintuitive predictions, such as the forward guidance puzzle. This paper directly test whether current economy can be significantly influenced through the expected inflation channel, by exploiting Japan's value-added tax hikes during periods at the zero lower bound. Using event study analysis supplemented by macro counterfactual analysis, our empirical results contradict the canonical models' predictions: future value-added tax hikes did not stimulate the current economy at all, nor did professional forecasters revise their economic forecasts towards economic improvement. It only affects inflation and consumption around the periods of the scheduled value-added tax hikes. These results cast doubt on the expected inflation channel. Finally, we provide a parsimonious model that account for our our empirical findings without relying on nominal rigidities.

JEL Classification: E31, E52, E62.

*Institute of Economic Research, Hitotsubashi University. Emails: yuta.takahashi@r.hit-u.ac.jp and ntakayama@ier.hit-u.ac.jp. This work is supported by JSPS KAKENHI Grant Numbers JP21K13256 and JP22K13363. We appreciate discussion with Jean-Paul L'Huillier and Yuichiro Waki. We also acknowledge comments from Tamon Asonuma, Nao Sudo,

1 Introduction

A central pillar of New Keynesian models is the role of expected inflation in shaping macroeconomic dynamics. Forward-looking price setting and consumption decisions imply that current economic activity can be manipulated through the expected inflation channel —an insight that underpins both the theoretical potency of fiscal stimulus at the zero lower bound of nominal interest rate and a range of counterintuitive predictions, such as the forward guidance puzzle. Despite the prominence of this mechanism in theoretical and policy debates, direct empirical evaluations of the expected inflation channel remain limited because it is hard to find shocks which directly affects expected inflation or equivalently the real interest rate.

In this paper, we scrutinize this core mechanism by exploiting Japan's unique episodes of value-added tax hikes implemented at the zero lower bound. In August 2012, the Japanese legislature enacted a law to raise the value-added tax rate from 5% to 8% in April 2014 and to 10% in October 2015. While the first hike proceeded as scheduled, the second was postponed twice, eventually taking place in October 2019. These well-publicized announcements provide a unique opportunity to study the effects of expected future inflation channel at the zero lower bound.

Beyond providing a rare opportunity to test the empirical validity of the mechanism, these cases also bear significant policy relevance. The same mechanism suggests that a government spending multiplier can be large and forward guidance monetary policy and value-added tax hike are effective policies at the zero lower bound. It is therefore crucial to empirically verify whether this mechanism operates as predicted. Japan's experience provides exceptionally clean examples for such scenarios since the country has been clearly constrained at the bound.

We begin by analyzing the effects of the announcements on tax hike schedule through event study analysis. We analyze how professional forecasters revise their forecasts before and after the announcement of a value-added tax hike and its subsequent postponements. These revisions reflect all the information available around the events. We can conduct a separate event study for each of three announcements.

In the first event study, we analyze how the initial announcement of value-added tax hikes affect professional forecasts. We find that professional forecasters did not significantly revise their forecasts for inflation or consumption in the immediate period following the announcement. Revisions to consumption growth rates were observed only in the one or two quarters immediately preceding the first value-added tax hike in April 2014, reflecting expectations of a temporary surge in demand just before the hike. There was no strong

impact on forecasts for the current economy at the time of the announcement. These findings contrast starkly with the predictions of the New Keynesian model.

The first event study faces two limitations. First, forecasts for the exact timing of the April 2014 tax hike are unavailable, as the survey conducted around the 2012 announcement does not cover that period in the forecast horizon. Only data up to the quarter just prior to the hike are available. Second, the announcement date of the value-added tax hike is difficult to identify precisely. As a result, we adopt a wide event window, within which confounding factors may obscure the genuine announcement effect. These limitations highlight the importance of the second and third event studies, in which the tax hike was unexpectedly postponed. The narrow event window around the postponement announcements, combined with the availability of forecast data on both sides of the originally scheduled implementation dates, allows for a more precise and credible assessment of the expected inflation channel.

Confirming the first event study, we find no evidence that the two postponement announcements induced forecasters to expect expansionary effects, contrary to New Keynesian predictions. Revisions to inflation and consumption forecasts were confined to the period immediately surrounding the originally scheduled date of value-added tax hike. Forecasts for other periods, both before and after the hike, were left entirely unchanged. Indeed, forecasts for inflation excluding the value-added tax remained virtually unchanged. These findings indicate that professional forecasts were unaffected beyond the narrow scope around the planned hike.

The salience of value-added tax hike announcements alters expected inflation. At the same time, this very salience hampers identification of their causal impact, since *all* forecasters observe the announcements. Although the event window for the postponements spans one month, potential confounding factors may still exist. To supplement the shortcomings in our identification strategy, we employ the macro counterfactual analysis proposed by Orchard et al. (2025). Using a minimal New Keynesian model, we construct counterfactual paths that would have prevailed in the absence of the event and evaluate their plausibility. The model predicts that, in the absence of the postponement announcements, inflation and consumption would have declined substantially—more severely than during the 2011 great earthquake in Japan. Given the absence of such large economic shocks in those months, we judge these counterfactual paths to be unreasonable. Consequently, we conclude that the strong feedback effects driven by expected inflation in New Keynesian models are not supported by the data.

In the final part of the analysis, we introduce a parsimonious model that accounts for the effects of announcements of the value-added tax hikes and their postponements. We deliberately adopt the simplest possible structure by extending a standard real business

cycle model along two dimensions. First, we allow households to purchase consumption goods in one period and consume them in later periods. Second, we assume intra-annual labor supply flexibility: households are willing to vary their hours worked across months within a calendar year. These two features weaken the tight link between consumption expenditure growth and the real interest rate. When the nominal interest rate is fixed, a constant real interest rate implies a constant inflation rate, while consumption expenditure can still respond strongly to the tax policy shock. Thus, we can replicate our empirical findings without relying on nominal rigidity.

This paper is relevant to three research streams. First, recent research examines the macroeconomic impacts of supply shocks and tax policies at the zero lower bound to test whether the counterintuitive predictions of New Keynesian models are empirically valid. The evidence suggests that they are not: adverse supply shocks are not expansionary at the bound (Cohen-Setton et al. (2017), Wieland (2019), Garín et al. (2019)) and that tax cuts are not contractionary (Kato et al. (2018), Cloyne et al. (2024)).[1] This paper, unlike these studies, uses well-identified announcements of value-added tax hikes and directly examines the relevance of the expected inflation channel by professional forecast data, allowing us to obtain sharper conclusions that the paradoxical implications of the New Keynesian model are inconsistent with the data.

Second, one body of work explores the implications of unconventional fiscal policy. Feldstein (2002) proposes that Japan should raise the value-added tax rate to stimulate the economy at the zero bound.[2] Correia et al. (2013) formalize and substantially generalize Feldstein's insight. They characterize the optimal unconventional fiscal policy and find that the first-best allocation is obtained by the proposed instrument. Seidl and Seyrich (2023) further generalize this equivalence by examining heterogeneous agent New Keynesian models. Eggertsson (2011) considers and assesses the desirability of various fiscal policies. In this paper, we examine whether the core mechanism of the New Keynesian models used in these papers is empirically plausible.

Finally, our work contributes to the literature on various forward guidance puzzles. The monetary forward guidance puzzle refers to the implausibly large effects that standard New Keynesian models predict when monetary policy commits to keeping future interest rates low (Eggertsson et al. (2003), Del Negro et al. (2023)). The same type of forward guidance puzzle exists in the realm of fiscal policy. It is well known in the literature that New Keynesian models predict a large government spending multiplier at the zero lower bound (Christiano

[1] See Dupor et al. (2009) which explore the implications of technology shock for the New Keynesian model when the economy is away from the zero lower bound constraint.

[2] Blanchard (2025) reexamines the effectiveness of value-added tax adjustments as a tool for macroeconomic stimulus when the nominal interest rate is at the zero lower bound.

et al. (2011), Eggertsson (2011), Woodford (2011), Farhi and Werning (2016)). When fiscal actions such as tax hikes or changes in government spending are announced in advance, canonical New Keynesian models predict exaggerated effects on current consumption and output (Canzoneri et al. (2018), Kiley (2016), Halperin (2023)). The mechanism behind these monetary and fiscal puzzles is the same as what makes a value-added tax hike expansionary. In this paper, we aim to examine whether this mechanism is supported by Japanese data.

The remainder of the paper is organized as follows. Section 2 outlines the theoretical framework for testing the implication of the New Keynesian model and quantifies the predicted impact of a value-added tax hike. Section 3 details our baseline analysis of Japan's value-added tax hikes, including data sources, basic institutional facts, and empirical results, and Section 4 provides a parsimonious model which account for our empirical findings. Section 5 concludes with policy implications and suggestions for future research.

2 Theory

This section introduces our theoretical framework based on the New Keynesian model. The only modification to the canonical structure is the inclusion of a value-added tax. Given the well-established nature of the New Keynesian model, we only outline the linearized equilibrium conditions around the model's efficient steady state.[3] Additionally, we analyze the model's dynamic response and conduct a simulation to demonstrate how an announcement of value-added tax hikes influences the economy over time.

2.1 Model

The model operates in discrete time and is deterministic. There are three types of agents: households, firms, and the government. We introduce equilibrium equations that characterize their behavior. Throughout, all variables are expressed in log-deviation form.

Household behavior in this model is summarized by the Euler equation:

$$c_t = c_{t+1} - \sigma \left(r_t - \pi_{t+1} - (\tau_{c,t+1} - \tau_{c,t}) \right), \tag{1}$$

where c_t is aggregate consumption per capita, r_t is the nominal interest rate, π_t is the before-tax inflation rate, and $\tau_{c,t}$ is the value-added tax rate in period t. Thus, $\pi_t + (\tau_{c,t} - \tau_{c,t-1})$

[3] As shown in Mertens and Ravn (2014) and Christiano et al. (2018), this type of model often generates multiple equilibria when the nominal interest rate is pegged. Here, we implicitly select the equilibrium with a lower inflation rate, as the alternative equilibria imply implausibly high inflation that conflicts with the observed data. Given this equilibrium selection, the linearized model approximates the underlying non-linear model well.

corresponds to consumer price index (CPI) inflation. The parameter σ corresponds to the EIS.

Firm behavior is characterized by the New Keynesian Phillips Curve (NKPC):

$$\pi_t = \kappa c_t + \frac{\kappa}{\sigma^{-1} + \psi^{-1}} \tau_{c,t} + \beta \pi_{t+1}, \tag{2}$$

where κ is a parameter corresponding to the slope of this curve, and ψ is the Frisch elasticity of labor supply. This elasticity ψ,along with the EIS σ, determines the elasticity of the equilibrium real wage with respect to consumption. To derive equation (2), we assume that the final good is a CES composite of intermediate goods and that intermediate goods firms have identical linear technology but face the Calvo pricing frictions when changing their before-tax prices.[4] The second term on the right-hand side of equation (2) captures the effect of the tax on the real wage. A higher value-added tax reduces labor supply, leading to a higher real wage. This increase in real wage raises firms' marginal costs and shifts the NKPC.

The government sets the value-added tax rate $\tau_{c,t}$ and the nominal interest rate r_t. We assume that the government permanently fixes the value-added tax rate from period T^* and onward. Following the convention in the literature (Eggertsson et al. (2003)), we assume that the government uses the interest rate rule since the last value-added tax hike is implemented. The interest rate is assumed to be pegged to zero before the last value-added tax hike:

$$r_t = \begin{cases} \bar{r} & t < T^* \\ \phi_\pi \pi_t & t \geq T^* \end{cases}, \tag{3}$$

where $\bar{r} = \ln \beta < 0$. Japan's long-term real interest rate has been close to zero, implying that β is sufficiently close to zero. Given the parametrization below, we simply assume that $\bar{r} = 0$, but this assumption is made only for expository convenience. Without this assumption, an additional stimulative term would emerge, further strengthening our argument.

Equations (1), (2), and (3) characterize the equilibrium of this economy. Notice that since $t \geq T^*$, the steady state shifts since the value-added tax rate increases permanently. The steady state inflation rate is still zero, and the steady state consumption implied by the linearized system, c^*, becomes $c^* = -\tau_c / (\sigma^{-1} + \psi^{-1})$, where τ_c is the value-added tax rate at the steady state. Since we focus our analysis on the bounded equilibrium and assume that the Taylor rule with the Taylor principle is operative for $t \geq T^*$, we obtain the usual terminal conditions, $c_{T^*} = c^*$ and $\pi_{T^*} = 0$. This completes our characterization of the model.[5]

[4] This assumption is supported by Japanese data and is used in Correia et al. (2013), who argue that it is also strongly supported in Europe.

[5] We can explore the implications of the model when the tax revenue is not rebated to the household, and

2.2 Dynamic Responses to a Value-Added Tax Hike

To examine how the announcement of a value-added tax hike impacts the economy, consider a scenario where the government announces in period 0 that a value-added tax hike will occur only once in period T^*; specifically, $\tau_{c,t} = 0$ for all $t < T^*$, and $\tau_{c,t} = \tau_c > 0$ for all $t \geq T^*$. This announcement of the value-added tax hike affects the economy in three ways. First, it directly increases the inflation rate of period T^*, since $\tau_{c,T^*} - \tau_{c,T^*-1} > 0$. Then, the real interest rate declines, encouraging households to increase consumption immediately before the value-added tax hike. Second, as noted above, the value-added tax hike permanently lowers the consumption level at the new steady state. This negative effect on consumption partially offsets the first positive effect. The total effect on consumption in period $T^* - 1$ is

$$c_{T^*-1} = \underbrace{\sigma\tau_c}_{\text{Real rate effect}} \quad \underbrace{-\gamma\tau_c}_{\text{Steady state effect}} = (\sigma - \gamma)\,\tau_c > 0, \tag{4}$$

where $\gamma = (\sigma^{-1} + \psi^{-1})$ and is is strictly lower than σ, $\gamma < \sigma$. Thus, announcing a value-added tax hike in period 0 has an expansionary effect on consumption in period $T^* - 1$, $c_{T^*-1} > 0$. Third, the value-added tax hike elevates production costs and, combined with increased demand driving up wages, results in higher inflation, π_{T^*-1}. Their magnitudes depend on the size of the shock τ_c and household preferences σ and ψ.

Aggregate demand is stimulated ($c^*_{T-1} > 0$) and inflation increases ($\pi_{T^*-1} > 0$) while the nominal interest rate remains fixed in period $T^* - 1$ ($r_{T^*-1} = 0$). As a result, the economy experiences additional stimulation in period $T^* - 2$ through the Euler equation (1) and the NKPC (2), leading to higher aggregate demand and elevated inflation in that period. These stimulative effects cascade backward, causing a substantial increase in both current consumption and inflation in period 0. Moreover, the longer the government postpones the implementation of a value-added tax hike, the greater the stimulation of current consumption and inflation. In the extreme scenario where the government implements the value-added tax hike in an infinitely distant future, both consumption and inflation would diverge, with $c_0, \pi_0 \to \infty$ as $T^* \to \infty$. This phenomenon can be seen as a variant of the fiscal forward guidance puzzle in Canzoneri et al. (2018).

It is worth noting that the mechanism of a value-added tax hike operates in a manner similar to how a future monetary policy shock affects the economy. To demonstrate this similarity, let us assume that the government lowers the nominal interest rate to

$$r_{T^*-1} = -\frac{\sigma - \gamma}{\sigma}\tau_c, \tag{5}$$

the terminal inflation differs from zero, as analyzed in Cochrane (2017).

in period T^*-1. Since the monetary policy shock does not affect the steady state consumption level, this monetary policy shock increases consumption in period T^*-1 by the same amount that the value-added tax does, as shown in (4). Therefore, the dynamic responses of inflation and consumption for $t \leq T^* - 1$ to this monetary shock are identical to those of the value-added tax shock. In other words, this unconventional fiscal policy can be understood as a monetary forward guidance shock.[6] Moreover, this pseudo monetary policy shock is not constrained at the zero bound, and can become arbitrarily negative, effectively implementing a deeply negative interest rate policy. We summarize our findings in a proposition.

Equation (5) allows us to quantify the magnitude of the value-added tax hike shock. Using $\sigma = 0.5$ and $\psi = 0.75$ (i.e., $\gamma = 0.3$), which are standard parameter values in macroeconomic literature, an increase of 3.0 percentage points in the value-added tax rate corresponds to a decline of 4.8 percentage points in the annualized nominal interest rate. Considering that the US Federal Reserve typically adjusts its policy interest rate by 0.25 percentage points per annum, the magnitude of this monetary policy shock is enormous. Consequently, the value-added tax shock is equally substantial.

This analysis highlights a key advantage of fiscal instruments like value-added tax hikes: they can replicate the effects of conventional monetary policy without being subject to the zero lower bound constraint. Unlike nominal interest rates, value-added tax hikes can lower the real interest rate without bound by influencing inflation expectations. As demonstrated, a tax hike with reasonable size can generate a shock equivalent in scale to an enormous expansionary monetary policy shock. This feature of value-added tax hikes makes this policy particularly valuable in environments where conventional monetary policy is constrained or exhausted, at least in theory.

We summarize our near-equivalence result as a proposition:

Proposition 1. *The dynamic responses of inflation and consumption up to $T^* - 1$, and $(\pi_t)_{t=0}^{T^*-1}$ and $(c_t)_{t=0}^{T^*-1}$, of the value-added tax hike policy announced in period $t = 0$ are the same as those resulting from the following expansionary monetary policy shock in $T^* - 1$:*

$$r_{T^*-1} = -\left(\frac{\sigma - \gamma}{\sigma}\right)\tau_c.$$

2.3 Simulation of the Two Value-Added Tax Hikes

Building on the theoretical analysis presented earlier, we now employ simulations to examine the economic impact of the government announcing two value-added tax hikes, inspired by

[6]Similar equivalence is established in the literature. See Correia et al. (2013), who study representative-agent models ,and Seidl and Seyrich (2023), who analyze heterogeneous-agent models.

the Japanese case. The government declares both tax hikes in period 0, with implementations scheduled for periods 7 and 13. Our model operates on a quarterly basis, which implies that the tax hikes take effect after a year and three quarters and after three years and a quarter, respectively. The value-added tax is initially raised by three percentage points and subsequently by five percentage points.

We adopt the following conventional parameter values:

$$\beta = 0.99975, \sigma = 0.5, \psi = 0.75, \text{ and } \kappa = 0.08. \tag{6}$$

The discount rate β is chosen to ensure that the steady state annualized real interest rate is 0.1%. We set the elasticity of intertemporal substitution to 0.5, consistent with Eggertsson et al. (2003) and McKay et al. (2016). The Frisch elasticity of labor supply is assigned a value of 0.75, as suggested by Chetty et al. (2011). The slope of the NKPC is set to 0.08, based on Galí (2015).

In Figure 1, we simulate the economy following the announcement of the value-added tax hikes under parametrization (6). Figure 1 illustrates the dynamic responses of inflation and consumption.[7] Consistent with our theoretical analysis, the announcement of value-added tax hikes generates a strong positive feedback effect on both current consumption and inflation. The annualized inflation rate surpasses 5% in the first year on average, a level far from actual Japanese rates in the early 2010s. The impact on consumption is also significant, with current consumption rising by approximately 4%.

It is important to emphasize that our analysis is entirely positive in nature. The value-added tax introduces distortions into the economy and reduces the welfare of the representative household. Following a value-added tax increase, consumption declines permanently, represented the shaded area in Figure 1. Anticipated future hikes in the value-added tax stimulate a temporary economic boom, but at the cost of future consumption stagnation.

Before concluding this section, we examine how the economy evolves following a postponement of the value-added tax hike. This analysis is relevant, as the Japanese government postponed the second scheduled hike twice. Suppose the government initially announces the tax hike in period 8, but then unexpectedly announces in period 3 that it will be postponed to period 12. We simulate the model's responses to both the initial announcement and the subsequent postponement. Figure 2 plots the corresponding dynamics. After the initial announcement, the economy experiences a short-term boom, as discussed earlier. When

[7] As detailed below, we utilize forecast data on inflation and consumption. The dataset contains forecasts of year-on-year inflation rates and quarter-on-quarter consumption growth, since they are the headline series that professional forecasters focus on as in the United States. Because year-on-year inflation compares the current price level to that of the same quarter in the preceding year, it remains elevated for four periods following the value-added tax hikes.

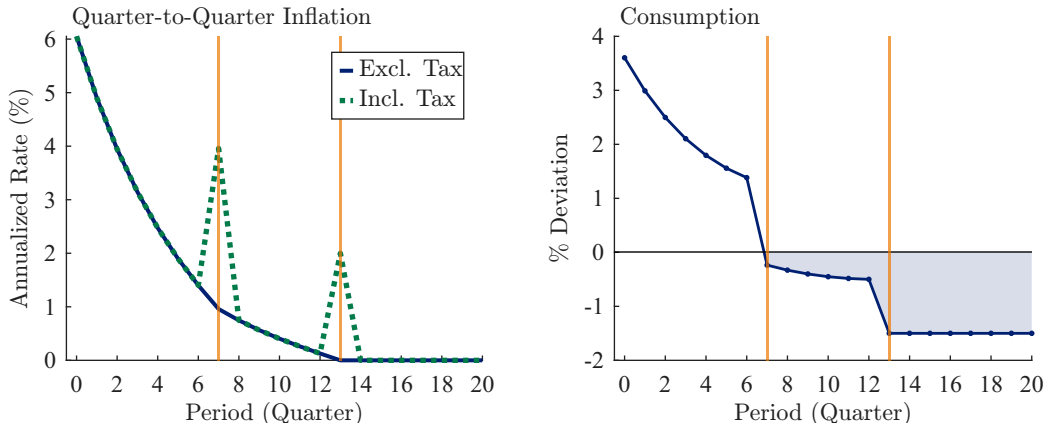


Figure 1: Dynamic Responses for Value-Added Tax Hikes

Notes: Without loss of generality, we normalize the pre-shock prices and consumption to one. The yellow solid lines indicate the period when the first and second value-added tax hikes are implemented.

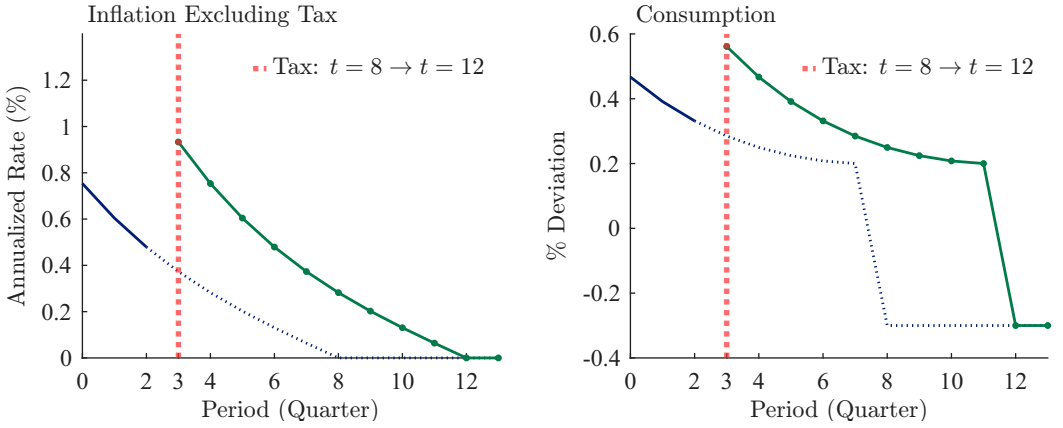


Figure 2: Dynamic Responses for Postponement of Value-Added Tax Hike

the government announces the postponement in period 3, which is indicated by the vertical dotted red line, the economy adjusts immediately to the new equilibrium, with inflation and consumption represented by the solid lines with marker "o". Since a tax hike scheduled further in the future is more expansionary, the postponement stimulates the current economy. This mechanism mirrors the logic of the forward guidance puzzle: a one-percentage-point reduction in the nominal interest rate has a larger stimulative effect the farther in the future it occurs.

In sum, the minimalist New Keynesian model predicts that announcements of a value-added tax hike—or its postponement—can stimulate the current economy. The next section assesses whether these theoretical predictions are consistent with Japanese data.

3 Analysis of Japanese Value-Added Tax Hikes

In this section, we analyze the Japanese economy before and after the value-added tax hikes in the 2010s. We first summarize basic institutional facts about the value-added tax hikes, introduce our dataset, and show basic data patterns. Subsequently, we conduct empirical exercises to examine the value-added taxes.

3.1 Basic Institutional Facts

Before proceeding with the formal statistical analysis, we briefly review the basic institutional facts regarding Japan's value-added hikes in the 2010s. This study covers 2000 to 2019, which is widely recognized as a time when the Japanese economy was constrained by the zero lower bound (Miyamoto et al. (2018), Wieland (2019)). Simultaneously, the value-added tax was a significant focal point in Japanese policy debates. Advocates of fiscal consolidation argued that a higher value-added tax rate was necessary to avoid a fiscal crisis, as the debt-to-GDP ratio kept rising due to expanding social security expenditures in Japan's rapidly aging society. On the other hand, raising the value-added tax rate was unpopular among the Japanese public, and opponents insisted that the damage to household purchasing power after such a tax hike would be the final blow to the already weak Japanese macroeconomy.

Amid this heated debate, a pivotal change was made by Prime Minister Yoshihiko Noda, a notable fiscal consolidation advocate. In what follows, we concisely yet comprehensively document the dates of important events on which significant new information was disseminated to the political and economic agents.[8] On December 29, 2011, he led the tax commission in his ruling party to propose a plan to raise the value-added tax rate from 5% to 8% on April 1, 2014, and from 8% to 10% on October 1, 2015. His cabinet submitted a bill to the congress, on March 30th, 2012. However, bill's fate was highly uncertain at that point, because his ruling party did not secure the majority needed in the upper house. Moreover, he faced significant opposition even within his own party. To forge a path toward passage of the bill, Noda negotiated with two major opposition parties, and a three-party agreement for the hikes was reached on June 15, 2012. With this momentum, the Japanese congress passed the bill with amendments on August 10, 2012. This process was fraught with difficulties and cost Noda his entire political capital. It led to a split in his ruling party and compelled him to promise the opposition parties a dissolution and general election of the lower house. Consequently, he lost power in December 2012.

[8] Those events gain intensive media attention and are considered to be the critical moments regarding the value-added tax hikes in the 2010s. One can verify this with public sources such as the chronological archive compiled by the Tokyo Foundation, available at this URL in Japanese.

Prime Minister Shinzo Abe, who succeeded his predecessor, implemented the initial consumption tax hike in April 2014 as originally planned. However, consumption turned out to be weaker than anticipated following the hike. This weakness influenced Abe's decision to delay the subsequent hike. On November 18, 2014, he announced that the second hike, initially set for October 1, 2015, would be postponed to April 1, 2017. To legitimize the decision, he dissolved the lower house and called a general election, which he won on December 14, 2014.

Nevertheless, the second hike was postponed further. On June 1, 2016, Abe declared another delay, shifting the second hike to October 1, 2019, citing the risk of a global economic crisis. This decision was politically validated through a victory in the upper house election held on July 10, 2016. The second tax hike was eventually carried out in October 2019. To analyze how tax policy announcements affect expectations, we focus on the initial announcement of the first consumption tax hike and the two subsequent announcements postponing the second hike.[9]

3.2 Datasets

In our analysis, we use confidential dataset containing professional forecasts and publicly available datasets. For forecast data, we use confidential micro data from the ESP forecast survey, which were provided by the Japan Center for Economic Research. The survey collects monthly forecasts from approximately 40 professional economists in the private sector. These economists provide their quarterly forecasts on key indicators such as real private consumption growth, inflation, unemployment rates, the Nikkei stock average, and the US dollar-yen exchange rate. For our purposes, we use the forecasts related to consumption growth and inflation. The survey explicitly requests forecasts of the year-on-year inflation rate excluding fresh foods, as well as forecasts for real final goods expenditure. The series of quarterly inflation forecasts begins in January 2004, whereas the corresponding series for consumption growth is available only from January 2009. To measure actual inflation and consumption growth, we use the corresponding quarterly CPI inflation rate and consumption growth.[10]

Similar to other professional forecast datasets, this dataset incorporates monthly updates for the current and subsequent quarters. This dataset allows us to track the revision history of forecasts for a given quarter. On the other hand, distinct from other forecast surveys,

[9]The second hike was accompanied by a reduced tax rate of 8% for goods such as food and non-alcoholic beverages and the introduction of large-scale subsidies for kindergartens and child day care fees. The resulting variation in tax rates across goods induces distortions in relative prices. A comprehensive analysis of these effects requires a more sophisticated model, which we leave to future work.

[10]Specifically, we use the seasonally adjusted private consumption growth in the national accounts.

this dataset has collected, starting in October 2013, forecasts for the consumer price index excluding the impact of the value-added tax.

3.3 Descriptive Analysis of Professional Forecast Data

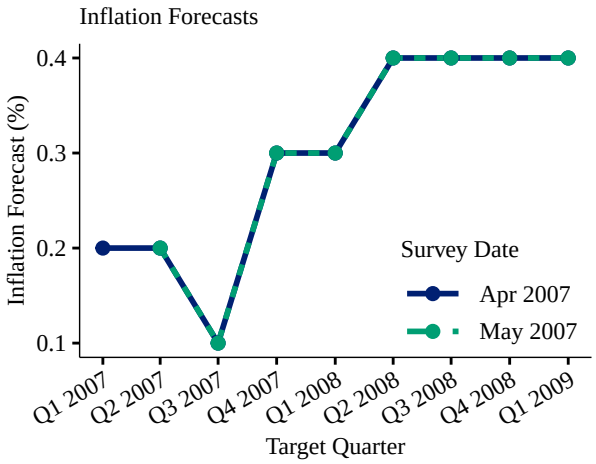
As an illustration of our forecast dataset, Figure 3a presents inflation forecasts submitted by a specific respondent in April and May 2007. The forecast paths are identical, implying that no new information arrived that would have prompted a revision in the respondent's expectations.[11] Accordingly, the forecast revisions for the second quarter of 2007 and beyond are exactly zero.

In contrast, there are episodes in which the same respondent adjusted the respondent's forecasts in response to new information. Figure 3b shows the respondent's forecast reported in January and February 2009, during the midst of the Great Recession in the United States, which had repercussions for the Japanese economy. In February, the respondent revised the short-run inflation forecasts downward significantly, while leaving the longer-run expectations largely unchanged. In general, these revisions contain meaningful information and will therefore be analyzed in later sections.

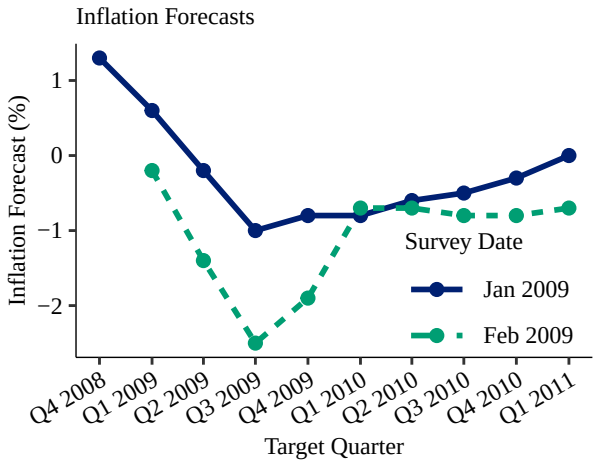
As mentioned above, a key strength of our dataset, relative to other professional forecast data, lies in the availability of inflation forecasts both inclusive and exclusive of the impact of value-added tax from October 2013 onward. This feature allows us to assess the perceived credibility of the tax hikes. Figure 3c presents the same respondent's forecasts as of October 2013. The solid line denotes the forecast including the value-added tax, while the dotted line indicates the forecast excluding it. The first scheduled value-added tax hike, set for April 2014, is marked by the vertical red dotted line. If the tax hike had not been viewed as credible, the two forecasts would overlap. Instead, Figure 3c shows a notable gap between them, implying that the respondent expected the tax hike and considered it credible. This pattern was typical among professional forecasters. As shown in more detail later, all respondents viewed the tax hikes as credible.

We now proceed to discuss average properties of the professional forecasts. In Figure 4a, we depict the actual realized inflation rate, the average nowcasted inflation rates, and the average one-year-ahead forecasts. The nowcasted series refers to the forecast reported for the contemporaneous quarter. The average nowcasted inflation rate closely tracks the actual inflation rate, suggesting that they correctly understand what they are supposed to

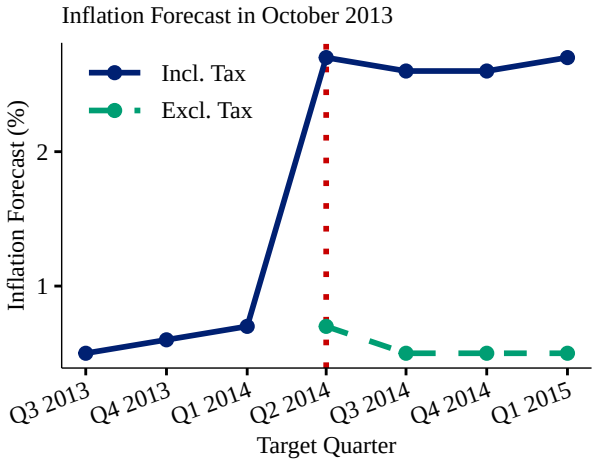
[11] It cannot be asserted with certainty that the respondent received no new information. The respondent might have received both positive and negative information, which neutralized each other and left the respondent's forecast unchanged.



(a) Inflation Forecast During Normal Periods



(b) Inflation Forecast During the Great Recession



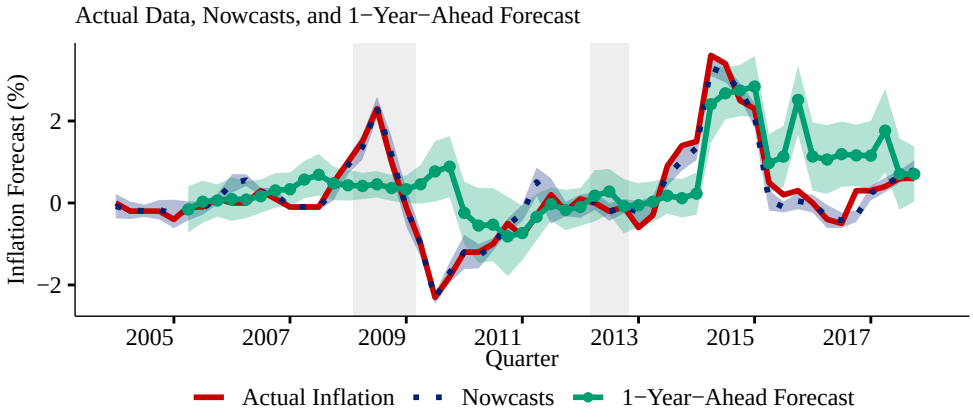
(c) Inflation Forecast Including and Excluding Tax

Figure 3: Inflation Forecast of a Particular Respondence

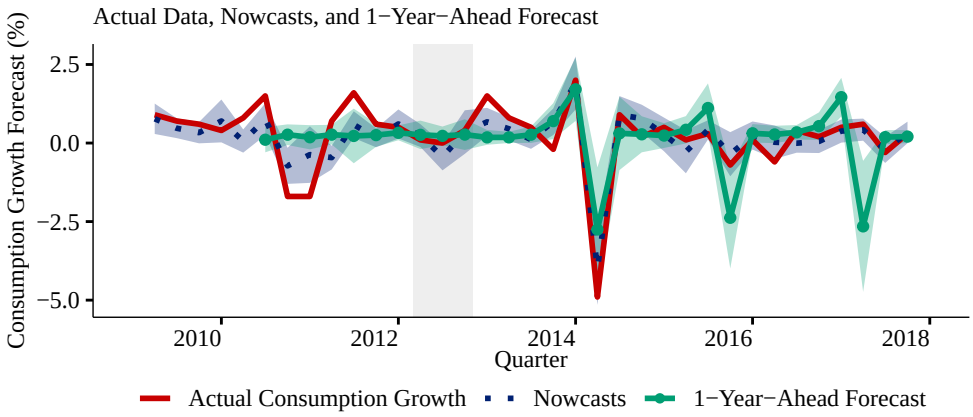
Notes; The vertical red dotted line in Figure 3c indicates the scheduled implementation date of the first value-added tax increase.

report.[12] As expected, the average one-year-ahead forecasts exhibit greater deviations from realized inflation and wider standard errors compared to now-casted inflation. Three spikes have appeared since 2014, corresponding to anticipated value-added tax hikes. The first hike was executed as planned, and the one-year-ahead forecast on year-on-year inflation rose for four quarters. The second and third spikes, however, were short-lived, as the planned value-added tax hikes were postponed in both cases, resulting in only a one-quarter uptick in the forecast.

[12]In typical household surveys, the average now-casted inflation rates differ substantially from the actual inflation rates. For example, see Opinion Survey conducted by the Bank of Japan available at this webpage. The average nowcasted inflation rates is exceeding the 2 % target inflation rate by a few percentage points for substantial periods.



(a) Inflation



(b) Consumption Growth

Figure 4: Mean Forecasts of Inflation and Consumption Growth

Notes: Shaded gray bars indicate periods of recession in Japan. The solid red lines trace the realized quarterly inflation and consumption growth. The dotted blue lines depicts the average nowcasts, constructed from the most recent survey responses available in each quarter. The solid green lines with overlaid points represents the average one-year-ahead forecasts. Shaded bands around the forecast lines denote 95 % confidence intervals calculated from the cross-sectional standard deviation of survey responses.

In Figure 4b, we draw the same forecasts for consumption growth. There are two main distinctions between forecasting consumption and forecasting inflation. First, even nowcasts often deviate from actual consumption growth. This is primarily because of the noisiness of real consumption data, which is subject to various shocks. Second, the standard deviation of nowcasts for consumption tends to be higher than for inflation. In contrast, one-year-ahead forecasts of consumption growth are typically anchored, with low cross-sectional dispersion among forecasters.

3.4 Event Study

At first glance, Figure 4 appear to rule out any strong feedback effects via expected inflation, as demonstrated in Figure 1. One-year-ahead forecasts suggest that the April 2014 value-added tax hike influenced inflation expectations but failed to generate any clear inflationary momentum beforehand. Similarly, the forecasts point to a brief consumption surge prior to the hike and a decline at the time of implementation, with no sustained stimulus effects beyond these points. Yet, we cannot soundly reject the strong feedback effect without isolating the genuine impact of the tax hikes on those expectations from other confounding factors. In what follows, we aim to rigorously identify the true effects of the tax hike and its postponement. To isolate the true effects of the tax hike and its postponement cleanly, we apply the event study method.

3.4.1 Framework

We begin by notations. Let $\pi_i(T \mid t)$, $\pi_i^{-\tau}(T \mid t)$ and $g_i(T \mid t)$ denote forecaster i's forecasts on inflation, inflation excluding the value-added tax, and consumption growth, for period T formed in period t. As mentioned above, T is quarterly and t is monthly. Suppose that a particular event (e.g., an announcement of future value-added tax hike) occurs between t' and t''. To isolate the impact of the event, we analyze how forecasters revise their forecasts after this event occurs. Mathematically, the revisions are expressed as follows:

$$\begin{aligned}
\Delta\pi_{i,T} &\equiv \pi_i(T \mid t'') - \pi_i(T \mid t') \\
\Delta\pi_{i,T}^{-\tau} &\equiv \pi_i^{-\tau}(T \mid t'') - \pi_i^{-\tau}(T \mid t') \\
\Delta g_{i,T} &\equiv g_i(T \mid t'') - g_i(T \mid t').
\end{aligned}$$

These revisions express how new information between t' and t'' affects i's forecasts. Since professional forecasters do have heterogeneous forecasts, we run the following regressions to decompose the effects of the revisions into idiosyncratic components, captured by forecaster fixed effect θ_i, and the aggregate component, which is captured by time fixed effect θ_T:

$$\Delta\pi_{i,T} = \theta_i + \theta_T + \varepsilon_{i,T}^1 \tag{7}$$

$$\Delta\pi_{i,T}^{-\tau} = \theta_i + \theta_T + \varepsilon_{i,T}^2 \tag{8}$$

$$\Delta g_{i,T} = \theta_i + \theta_T + \varepsilon_{i,T}^3. \tag{9}$$

The object of our interest is the time fixed effect θ_T, which captures all the general equilibrium effects on variables in period T. Note that this time fixed effect contains the effect of the event of our interest and all the other new information available between periods

t' and t''. Since our interest of events, the value-added tax hikes, are highly public in Japan and all agents are well-informed simultaneously, the data cannot provide placebo forecasters who remain unaware of the hikes and treatment effects cannot be recovered directly. Consequently, this analysis should not be interpreted as identifying the causal impact of the value-added tax hike announcement or its postponements. Nevertheless, we contend that the findings offer informative implications, especially when combined with additional empirical investigation with different approaches in Section 3.5.

3.4.2 Events

To apply the event study, we need to determine when professional forecasters perceived the announcements of the hikes and subsequent postponements. We explain how we identify the timing of the initial announcement of the value-added tax hikes, which is more ambiguous than the subsequent postponements. Unlike the two postponements of the second hike, it is difficult to pinpoint a specific date or month for the initial announcement. As Section 3.1 shows, although the initial plan for two hikes—scheduled for April 2014 and October 2015—had already been officially proposed by the ruling party on December 29, 2011, and a corresponding bill was submitted by the cabinet to the congress on March 30, 2012. Even after its submission to the congress, it remained uncertain whether the bill would be enacted, because the ruling party did not hold the necessary number of seats in the congress. Over time, negotiations among the ruling and opposition parties gradually progressed and proposed amendments to the bill. Accordingly, a growing number of forecasters began to report that they anticipated the value-added tax hike in April 2014. On August 10, 2012, the bill was enacted, but most forecasters had already anticipated the hike by then. Thus, for the announcement of the value-added tax hikes, we choose a wide range. We set January 2012 as the period before the event of the announcement, and September 2012 as the period right after the event.

Because identifying the timing of postponement announcements is more straightforward due to their swift or sudden nature, we can pinpoint the dates surrounding these announcements. The government announced the first postponement on November 18, 2014. This was the day after the release of the first GDP estimate for the third quarter of 2014. Given that the released GDP growth rate was negative for two consecutive quarters, the prime minister swiftly announced the postponement of the hike.

Similarly, we determine when the second postponement was perceived by professional forecasters. The prime minister announced it on June 1, 2016, which was considered rather sudden at the time. This is because his reason was the risk of a global economic crisis, whereas domestic and international macroeconomic conditions were not believed to be that

Event	Month Before Event	Month After Event
Value-Added Tax Hikes	January 2012	September 2012
1st Postponement	November 2014	December 2014
2nd Postponement	May 2016	June 2016

Table 1: Timing of Our Events

bad, even by government economists. Since the response deadline for the June 2016 wave of the survey was after June 1, we examine the revisions between the forecasts for June 2016 and those from the preceding month.

We summarize our dates for the events in Table 1. The first event occurred between January and September, so the revisions incorporate information from this entire period. Accordingly, it is likely that these revisions reflect a wide range of news beyond the value-added tax hike. In contrast, the postponements are assumed to have taken place within a single month, meaning that the revisions in this case only include information from that specific month, and are thus "clean" in this sense.

3.4.3 Discussion: Anticipation and Credibility

Before proceeding to the event study analysis, we examine whether professional forecasters treated the value-added tax hikes as credible. As illustrated in Figure 3c, we confirm credibility of i as follows: forecaster i perceives the hike scheduled for period T as credible in period t if

$$\pi_i\left(T|t\right) > \pi_i^{-\tau}\left(T|t\right). \tag{10}$$

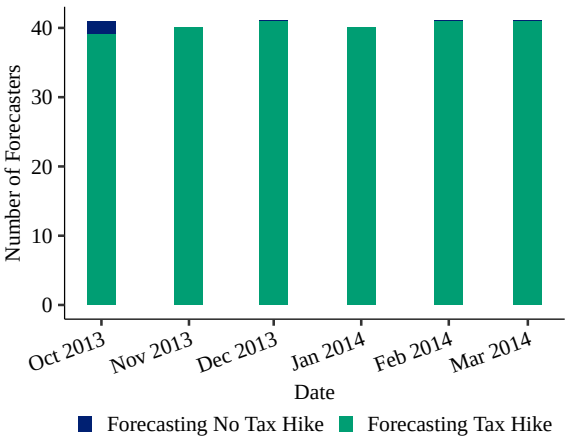
This condition (10) is sufficient for credibility, though not necessary. It remains theoretically possible that forecaster i anticipates the tax hike while misreporting the forecast.

Analogously, we examine whether forecasters anticipated the postponement of the second tax hike. In period t, forecaster i anticipates the postponement of the value-added tax hike scheduled for period Tif

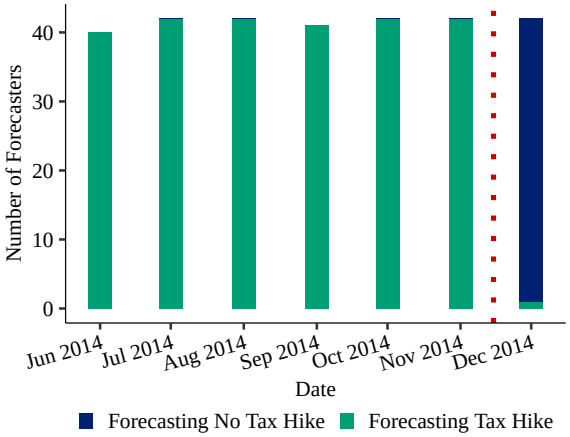
$$\pi_i\left(T|t\right) = \pi_i^{-\tau}\left(T|t\right). \tag{11}$$

As with credibility, this is a sufficient but not necessary condition.

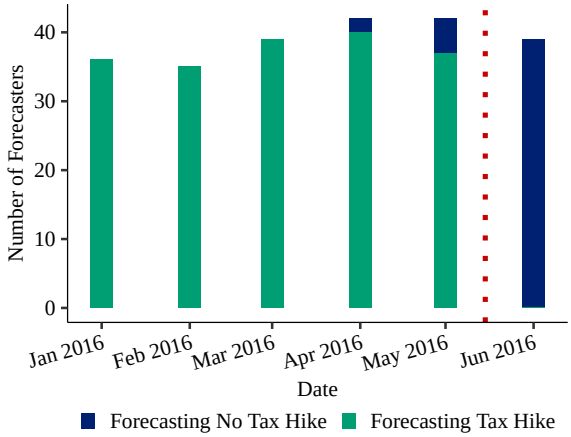
In Figure 5a, we present the number of forecasters, separated by whether they regarded the April 2014 tax hike as credible or not, covering the period from October 2013 through March 2014. Since forecasts of inflation excluding the value-added tax became available only from October 2013, that month serves as the earliest point of the figure. Two forecasters in October 2013 submitted forecasts that do not satisfy the credibility condition in 10. From



(a) April 2014 Tax Hike



(b) October 2015 Tax Hike



(c) April 2017 Tax Hike

Figure 5: Credibility of the Tax Hike and Anticipation of the Postponements

Notes; the red vertical dotted line represents when the government officially announced the postponement of the value-added tax hike.

November 2013 onward, however, all participants reported forecasts consistent with the tax hike being credible. Notably, the forecasts on April 2014 inflation including the value-added tax by the above two forecasters remained unchanged between October and November 2013, suggesting a potential misreport in October 2013. This is because if these forecasters had revised their views and come to regard the hike as credible in November, one would expect them to adjust their forecasts on inflation including value-added tax upward. Instead, they lowered their forecasts on inflation excluding value-added tax. In Appendix A, we depict and analyze their inflation forecasts in detail and conclude that these cases indeed reflect misreporting. We therefore conclude that the April 2014 tax hike was perceived as credible by professional forecasters.

We next examine the credibility of the second tax hike and the anticipation regarding

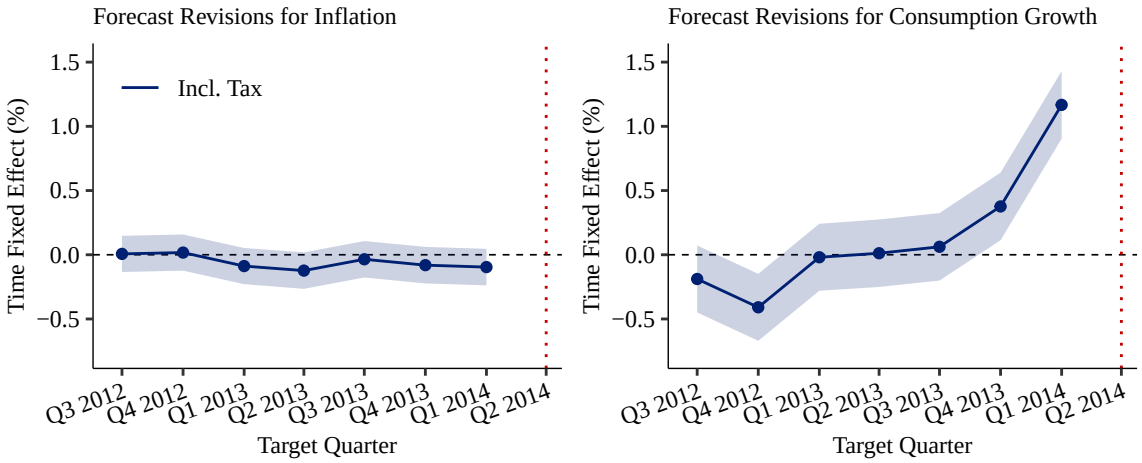


Figure 6: Effect of Announcement of Tax Hike

its initial postponement. Figure 5b presents the number of forecasters, again separated by whether they considered the October 2015 tax hike credible or not. The vertical dotted line indicates the date when the government officially announced the postponement. Initially, as Figure 5b shows, all forecasters regarded the hike as credible. Following the announcement, all but one forecaster revised their expectations and reported that the hike would be postponed. The one exception continued to treat the hike as credible. However, since the announcement was highly public and the forecaster subsequently revised their projection the following month, this response is likely a misreport.

Finally, we assess the credibility of the April 2017 tax hike and the anticipations regarding its postponement. Figure 5c, analogous to Figure 5b, reports the number of forecasters who considered the April 2017 tax hike to be either credible or not. The vertical dotted line marks the date of the government's announcement on second postponement. Again, all forecasters treated the hike as credible in early 2016. However, prior to the official announcement, several forecasters anticipated the postponement—two in April and three more in May. In our baseline analysis, we include all participants, but excluding these five forecasters does not materially affect the results. We study these cases in detail in Appendix B. A close review of their inflation forecasts suggests that no one anticipated any stimulative effects of the tax hike postponement.

3.4.4 Main Results

We now present the main empirical findings from our event study. We estimate time fixed effects using regressions (7), (8), and (9). The estimated time fixed effects are illustrated in 6 and 7. Detailed regression results are reported in Table 2.

We begin our discussion with the initial announcement of the value-added tax hikes. The

	Inflation Incl. Tax			Inflation Excl. Tax		Consumption Growth		
Event:	Hike	1st Post.	2nd Post.	1st Post.	2nd Post.	Hike	1st Post.	2nd Post.
Dep. Vars:								
T (current)	0.01	0.16	-0.02	0.08	0.02	-0.19	-0.16	-0.02
	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)	(0.05)
$T+1$	0.02	0.13	0.00	0.00	0.04	-0.41	-0.07	0.05
	(0.03)	(0.02)	(0.04)	(0.02)	(0.02)	(0.05)	(0.04)	(0.03)
$T+2$	-0.09	0.17	0.03	0.05	0.07	-0.02	-0.13	-0.21
	(0.03)	(0.03)	(0.04)	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)
$T+3$	-0.12	0.17	0.05	0.05	0.09	0.01	-1.04	-1.06
	(0.03)	(0.02)	(0.06)	(0.02)	(0.05)	(0.03)	(0.07)	(0.10)
$T+4$	-0.04	-1.03	-0.81	0.14	0.10	0.06	2.64	2.92
	(0.03)	(0.02)	(0.05)	(0.02)	(0.04)	(0.04)	(0.13)	(0.19)
$T+5$	-0.08	-1.00	-0.90	0.18	0.04	0.38	-0.34	0.06
	(0.03)	(0.02)	(0.05)	(0.02)	(0.03)	(0.05)	(0.05)	(0.06)
$T+6$	-0.10		-0.89		0.05	1.17		0.05
	(0.03)		(0.05)		(0.04)	(0.12)		(0.04)
$T+7$			-0.86		0.09			0.10
			(0.06)		(0.05)			(0.04)
Num. Obs.	251	252	307	252	307	251	252	307
R^2	0.63	0.94	0.76	0.60	0.39	0.73	0.89	0.84
R^2 Adj.	0.56	0.93	0.72	0.51	0.29	0.67	0.87	0.81
RMSE	0.16	0.14	0.27	0.15	0.21	0.29	0.41	0.48

Table 2: Event Study Analysis

Notes; The standard errors are clustered at participant level. The result for "inflation excluding tax" in relation to the announcement of the value-added tax hike is not available, as such forecast data are not reported for the relevant period.

left panel of Figure (6) displays the estimated time fixed effects θ_T for inflation including the value-added tax, while the right panel presents the corresponding estimates for consumption growth.[13] The vertical red dotted lines mark the scheduled period of the first value-added tax hike. Due to the limited forecast horizon, however, forecast data for the second quarter of 2014 are unavailable. This is because the quarter of the hike was still too distant to collect forecasts at the time, and the September 2013 survey round did not elicit forecasts for that quarter.

There are two noteworthy points. First, although the event window is broad, professional forecasters hardly revised their inflation forecasts prior to the tax hike. The left panel therefore implies that the information available from January to early September 2013—including the announcement of the value-added tax hike—did not affect inflation expectations. Second, forecasts of consumption growth were revised around the announcement period. In particular, consumption forecast surged just before the implementation of the tax hike. Given the implausibility of other distant-future shocks generating such a pattern, it is likely that forecasters incorporated the policy announcement into their expectations in the form of demand surge before the tax hike.

The patterns in Figure 1 appear inconsistent with the predictions of the New Keynesian model. While the model implies strong expansionary effects on both inflation and consumption, the figure shows no corresponding increases. However, it would still be premature to draw such a strong conclusion based solely on this figure, at least for two reasons. First, the event window is wide and includes numerous potential confounding factors, and so we cannot cleanly identify the effects of the value-added tax hike announcement. Second, limited forecast horizon prevent us from assessing the evolution of the forecasts for the time of the tax hike or thereafter. These limitations motivate the analysis of the unexpected postponement of the second value-added tax hike.

We redo the same exercise for the postponement of the October 2015 tax hike. Recall that the postponement announcement was sudden and publicly made in November 18, 2014. Thus, the outcome variables for regressions 7, 8, and 9 only contain the information newly available in November 2014. Since the event window is much tighter than the analysis for the initial announcement of tax hikes, the estimated time fixed effects contain less confounding factors than one in the previous analysis. Moreover, at the time of postponement announcement, the scheduled second hike was approaching and had already entered in the forecast horizon, Thus, the limited forecast horizon is not an issue for this case. In Figure 7a, we depict these estimated time fixed effects for inflation including the value-added tax (the solid

[13] Recall that before the October 2013 survey, inflation forecasts excluding the value-added tax were not collected.

line in the left panel), inflation excluding the value-added tax (the dashed line in the left panel), and consumption growth (the solid line in the right panel). The red dotted line represents the firth quarter of 2015, when the value-added tax hike was scheduled.

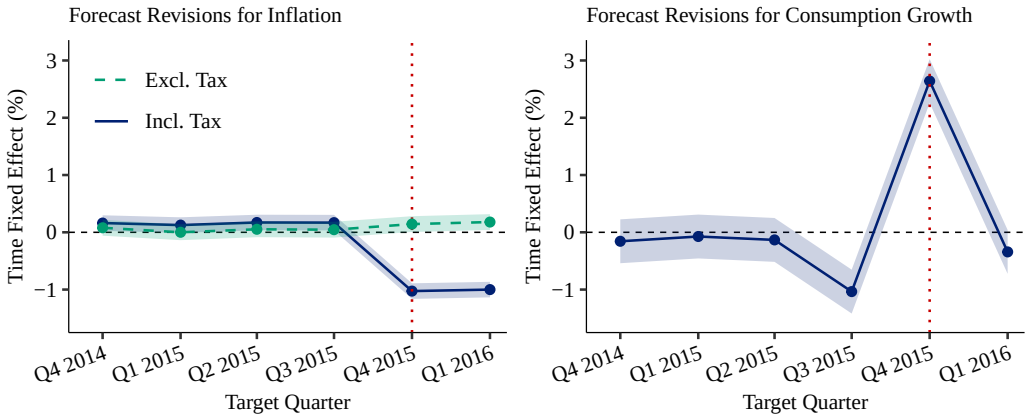
Figure 7a illustrates three key observations. First, professional forecasters' inflation expectations shifted markedly in November 2014. Starting in the fourth quarter of 2015, inflation forecasts including the value-added tax declined.[14] Second, in contrast, inflation forecasts excluding the value-added tax remained virtually unchanged. This implies that the net effect of new information released in November 2014 on both current and expected inflation—excluding the tax—was effectively zero. Third, future consumption was revised upward substantially, while current consumption remained broadly unchanged.[15] The upward revision reflects the expectation that consumption would have sharply declined had the tax hike been implemented as planned in the fourth quarter of 2015. Following the announcement of the postponement, forecasters stopped expecting such sharp decline and adjusted their consumption forecasts accordingly. The downward revision in consumption in the third quarter of 2015 likely reflects the removal of an anticipated surge in demand that would have occurred immediately ahead of the originally scheduled tax hike.

The last event study corresponding to the second postponement, depicted in Figure 7b, produces essentially identical results. The three key patterns outlined above are fully replicated in this case, lending further support to the robustness of our empirical findings. Inflation forecasts excluding the value-added tax remained entirely unchanged in May 2016. Consumption forecasts were revised upward for the period in which the value-added tax hike had been scheduled, while forecasts for the preceding period were revised downward. Forecasts for all other periods remained effectively unchanged in May 2016.

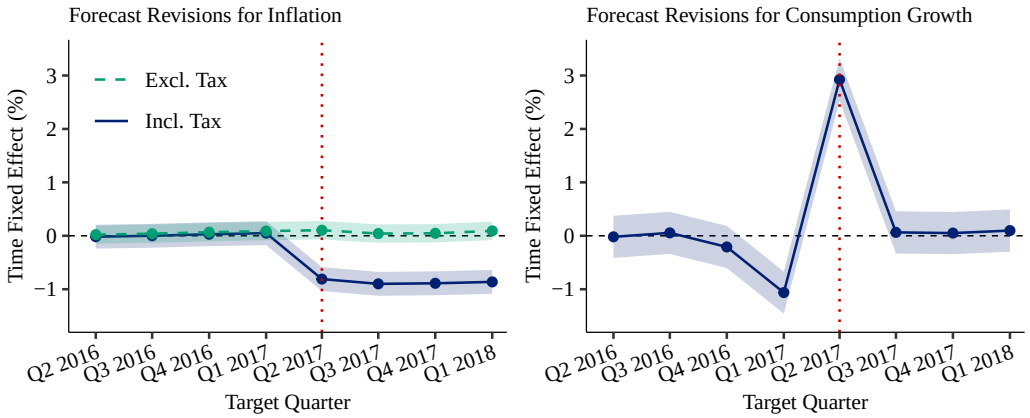
The three event studies clearly indicate that neither current inflation nor current consumption increased around the announcement dates. This pattern appears inconsistent with the basic predictions of the New Keynesian model. However, as noted earlier, it remains theoretically possible that other confounding factors offset the expansionary effects associated with each announcement. To investigate this possibility, we extend our analysis motivated by the macro counterfactual framework developed by Orchard et al. (2025), as presented in the next subsection.

[14] Because these forecasts refer to year-on-year inflation, the forecast for the first quarter of 2016 also reflected this downward revision.

[15] This muted consumption response implies that, although the Prime Minister Abe cited the weakness in the economy shown by the preliminary GDP estimate as the reason for the postponement, the same information did not prompt forecasters to revise their consumption forecasts downward. One interpretation is that forecasters disagreed with the severity of the downturn and perceived the postponement as being primarily politically motivated.



(a) October 2015 Tax Hike



(b) April 2017 Tax Hike

Figure 7: Effect of Postponement of Tax Hike

Notes; The shaded areas represent 95 % robust confidence intervals clustered by forecaster.

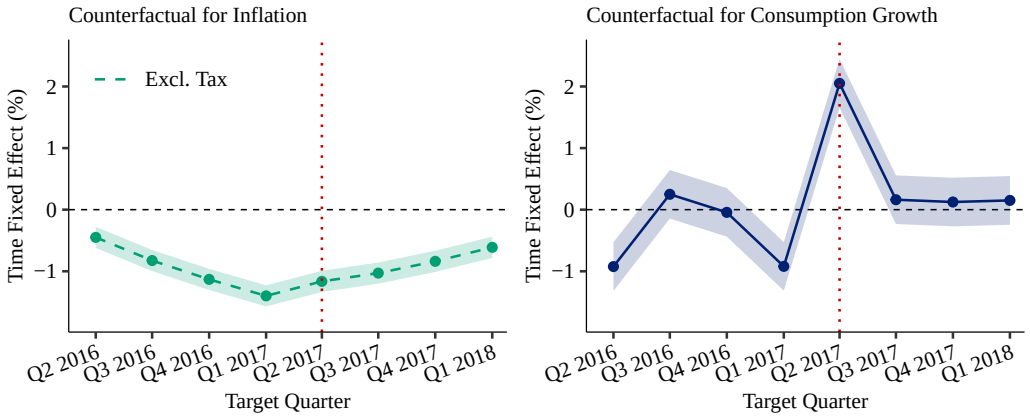


Figure 8: Counterfactual Scenario Without April 2017 Tax Hike

Notes: The vertical dotted red lines represent the second quarter of 2017, when the tax increase had been scheduled.

3.5 Macro Counterfactual Analysis

The macro counterfactual analysis involves constructing hypothetical macroeconomic paths that would have occurred *in the absence of a specific economic event*, using a macroeconomic model. These simulated "no-event" scenarios are then critically evaluated against historical narratives, real-time forecasts, and comparisons with other historical economic downturns to determine if they are plausible.

In our case, "event" corresponds to the announcement of the value-added tax hikes and the subsequent postponements. Then, we can remove the impacts of these three events using the minimalist New Keynesian model developed in Section 2 and construct the counterfactual scenarios without there events. We proceed to evaluate these counter-factual scenarios by comparing them with biggest economic events in Japan.[16]

Figure 8 shows the counterfactual scenario when the April 2017 tax hike was not postponed. In such a case, forecasters would revise inflation and consumption substantially. That is, there would be a negative shock which lowers inflation and consumption substantially.

We argue that these counterfactual scenarios are implausible in two respects. First, as shown in Figure 8, the estimated effect on current consumption is unrealistically large: a one-percentage-point drop in forecasts exceeds the 0.6 ppt reduction observed after the 2011 earthquake, and it is hard to maintain that such a massive shock went unnoticed by the press. Second, the two-percentage-point increase in year-ahead consumption forecasts far outstrips

[16] Orchard et al. (2025) use this powerful diagnostic tool utilized to assess the plausibility of microeconomic estimates and macroeconomic models. In the study of the 2008 tax rebates, they calibrated a standard macro model with estimated marginal propensities to consume (MPCs) to generate counterfactual consumption paths as if the rebate had never been issued. They proceed to examine plausibility of these simulated "no-rebate" scenarios

typical one-month revisions. Taken together with our event-study and macro-counterfactual analyses, these findings lead us to conclude that the basic predictions of the New Keynesian model are implausible.

4 A Parsimonious Resolution to the Puzzle

Our empirical findings indicate a robust pattern: changes in the value-added tax—whether an hike or a postponement—do not influence inflation at all. The effect on consumption is confined to intertemporal substitution around the time of the tax change. There is no evidence that such changes stimulate current consumption. In this section, we develop a parsimonious model that accounts for these empirical patterns. The model is deliberately kept as simple as possible and we show that the empirical patterns are explained by a frictionless monetary model.

Before formally introducing the model, we provide an overview of our model and intuition for why our model can replicate the empirical patterns. We consider a real business cycle model without capital. Unlike the standard RBC model, the representative household can purchase consumption goods in one period and consume them in later periods. As a result, observed consumption expenditure differs from actual consumption. We also assume that household members can adjust labor supply flexibly within the calendar year.

These two departures from the standard real business cycle setup help explain our findings. In the frictionless model, the real interest rate is tightly related to consumption growth by the representative household's Euler equation. Since actual consumption growth diverges from expenditure growth in our setup, expenditure can fluctuate around the tax change while consumption remains smooth. Indeed, the household purchases a large quantity of goods just before the tax hike and consumes them gradually over time. On the supply side, production is sufficiently flexible to accommodate this pattern. Labor can be reallocated across short-period of the time, with workers supplying more hours in some periods and fewer in others. The model thus accounts for the apparent disconnect between the real interest rate and the growth of consumption expenditure. Because the nominal interest rate is zero, inflation is fully pinned down. The constant real interest rate implies a constant inflation rate, consistent with the empirical evidence.

4.1 Environment

To illustrate the mechanism, we consider a four-period model in which the four periods jointly represent a single year; that is, each period corresponds to a quarter. Households are

continuously distributed over the interval $[0, 1]$. In each period, a household chooses expenditure, consumption, and labor supply. Let x_t, c_t, and l_t denote expenditure, consumption, and labor supply in period t, respectively. As intertemporal allocation is allowed, x_t and c_t may differ. The price of consumption goods in period t is given by p_t, and the value-added tax rate is τ_t.

The representative household's preferences are represented by the utility function

$$U = u\left(f\left(\mathbf{c}\right), g\left(\mathbf{l}\right)\right),$$

where $\mathbf{c} = (c_1, c_2, c_3, c_4)$ and $\mathbf{l} = (l_1, l_2, l_3, l_4)$ denote consumption and labor supply in each of the four quarterly periods. We impose zero elasticity of substitution in intra-year consumption and infinite elasticity in intra-year labor supply. Accordingly, we define:

$$f(\mathbf{c}) = 4 \min_t c_t, \quad g(\mathbf{l}) = \sum_t l_t.$$

This specification ensures complete consumption smoothing across quarters while allowing for flexibility in labor allocation. The utility function u is given by:

$$u(x, y) = \frac{x^{1-\sigma}}{1-\sigma} - \frac{\phi}{1+\psi} y^{1+\psi}, \quad \phi = 4^{-\psi}.$$

Thus, annual labor supply is not elastic.

The flow budget constraint for the household is given by

$$\left(1 + \tau_t\right) p_t x_t + b_t = R_t b_{t-1} + w_t l_t + T_t,$$

where T_t denotes the net transfer from the government. The corresponding life-time budget constraint is

$$\sum_t \left(1 + \tau_t\right) q_t p_t x_t + b_4 = R_0 b_{-1} + \sum_t q_t \left(w_t l_t + T_t\right),$$

where $q_t = \prod_{s=1}^{t} R_s^{-1}$. We assume that $b_{-1} = 0$ and the rationality of the household immediately implies $b_4 = 0$.

The representative household's maximization problem is stated as follows:

$$\max_{(x_t, c_t, l_t)_t} \quad u\left(f\left(\mathbf{c}\right), g\left(\mathbf{l}\right)\right) \tag{12}$$

$$s.t. \quad \sum_t \left(1 + \tau_t\right) q_t p_t x_t = \sum_t q_t \left(w_t l_t + T_t\right) \tag{13}$$

$$\sum_{t \le t'} c_t \le \sum_{t \le t'} x_t \quad \text{for all } t', \tag{14}$$

The second inequality in (14) captures the non-reversibility of consumption: goods can be stored for future use, but future goods cannot be consumed in advance.

On the supply side, the economy consists of a continuum of identical firms uniformly distributed over $[0,1]$. Each firm has a linear technology function, $y = l$. The representative firm maximizes its profit:

$$\max_{l_t} \quad p_t l_t - w_t l_t.$$

The good market clearing conditions are

$$x_t = l_t.$$

The competitive equilibrium for this economy is defined in the usual way.

4.2 Disconnect Between Consumption and Real Interest Rate

Now we consider the equilibrium response to the value-added tax hike,

$$\tau_t = \begin{cases} 0 & t \leq 2 \\ \tau & t > 2 \end{cases}.$$

We now characterize the response of the economy. Note that in this simple economy, the household can avoid the consumption tax completely by choosing $x_3 = x_4 = 0$. We establish the equilibrium.

Proposition 2. *The following quantities and prices constitute an equilibrium:*

$$\begin{aligned} c &= 1, l = 4, x_t = \begin{cases} 1 & t = 1 \\ 3 & t = 2 \\ 0 & t \geq 3 \end{cases} \\ p_t q_t &= 1, p_t = w_t. \end{aligned}$$

Proposition 2 has implications for the inflation rate. Taking the log difference of $p_t q_t$ yields the condition:

$$r_t + \pi_{t+1} = 0.$$

When the nominal interest rate is zero, then inflation is zero. Thus, the model can replicate the qualitative feature of the robust empirical pattern: the value-added tax hike has no impacts on current inflation and only affects consumption expenditgure around the value-added tax hike is implemented. While this model is intentionally simple, it can capture the

qualitative feature of the empirical pattern.

5 Conclusion

In this study, we empirically examine the effects of Japan's value-added tax hikes implemented under the zero lower bound of nominal interest rates. The standard New Keynesian model suggests that announcing a future value-added tax hike elevates expected inflation and stimulates current economic activity by reducing real interest rates. Contrary to this prediction, our analysis finds that neither professional forecasts nor actual data demonstrate such significant effects. Instead, inflation and consumption display only temporary fluctuations immediately before and after a tax hike, and the theoretically anticipated strong stimulative feedback effects are not observed.

Existing New Keynesian models exhibit these implausible strong feedback effects and are often used to argue for a large government spending multiplier and the effectiveness of forward guidance monetary policy. Our empirical findings cast doubt on this celebrated class of models, which have been intensively used for a variety of applications. Given the findings, we have discussed its implications for deep parameters and provided a potential resolution to the value-added tax puzzle. However, developing a full-fledged model that better aligns with our results and with other empirical regularities is a promising direction for future research.

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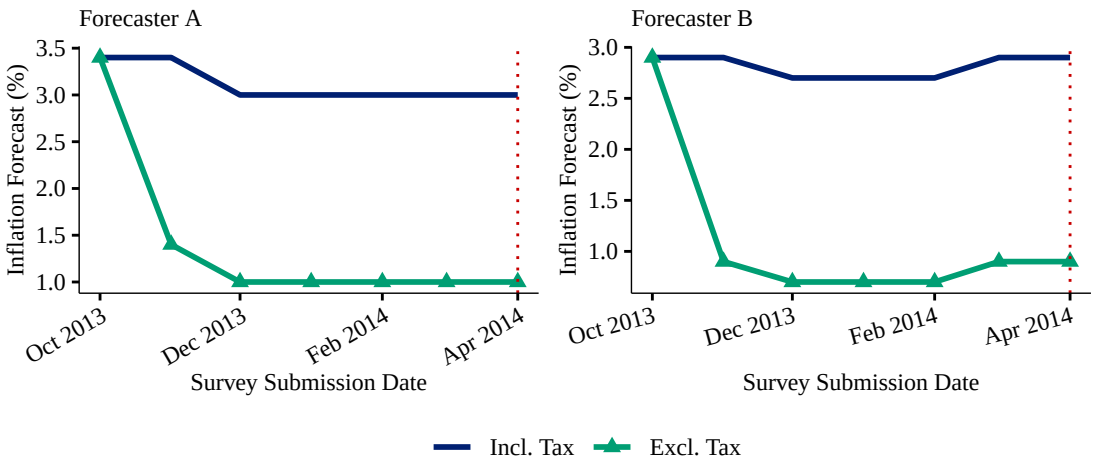


Figure 9: Inflation Forecasts Including and Excluding Tax for Two Outliers

Note: The vertical red dotted line marks the timing at which the value-added tax hike was planned to take effect.

A Misreport

Two respondents (hereafter denoted as forecasters A and B for convenience) provided the same inflation forecasts regardless of whether tax effects were included, implying that they appeared not to anticipate the scheduled tax hike in April 2014. Figure 9 displays their inflation forecasts for the second quarter of 2014 at each survey date. It reveals a large downward revision in tax-excluded forecasts from October 2013 to November 2013. If these forecasts are taken at face value, they would imply that the respondents became aware of the October 2013 tax hike only in that month and, at the same time, encountered an implausibly large disinflationary shock—reducing inflation by 2.5 percentage points without altering their tax-inclusive forecast. Given that the size of the shock is implausibly large and that no major economic events occurred in October 2013, the most plausible explanation is that the forecasts submitted in October contain reporting errors, which were revised in November. The fact that the survey only began collecting tax-excluded inflation forecasts in October 2013 suggests that these errors likely arose from misinterpretation of the newly introduced survey question.

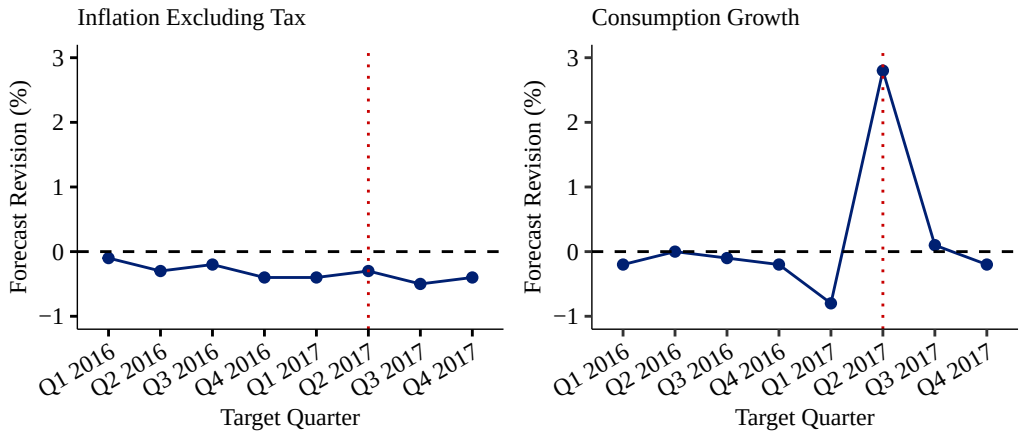
B Anticipations

Prior to the government's official announcement in mid May, two forecasters had already anticipated the postponement of the value-added tax hike in April, followed by three more in May. For convenience, we refer to these individuals as forecasters 1 through 5. We analyze

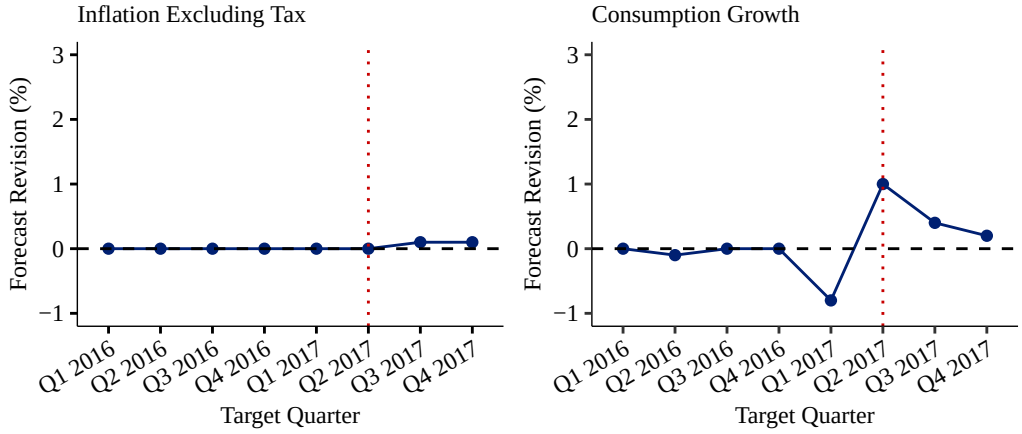
these five forecasters carefully. We find that none expected the postponement to have any stimulative, as the New Keynesian model suggests.

B.1 Forecasters Who Anticipated the Postponement in April

We compute the forecast revisions from March to April for forecasters who anticipated the postponement in April. Figure 10 displays the results, with each panel corresponding to a different forecaster. As shown in the figure, neither forecaster revised their current inflation and consumption forecasts upward. However, both increased their forecasts for second-quarter 2017 consumption growth—when the value-added tax increase was expected—although the magnitude of the revisions varies. These adjustments are consistent with the findings presented in Section 10. We therefore conclude that these forecasters do not exhibit strong feedback from expected inflation.



(a) Forecaster 1



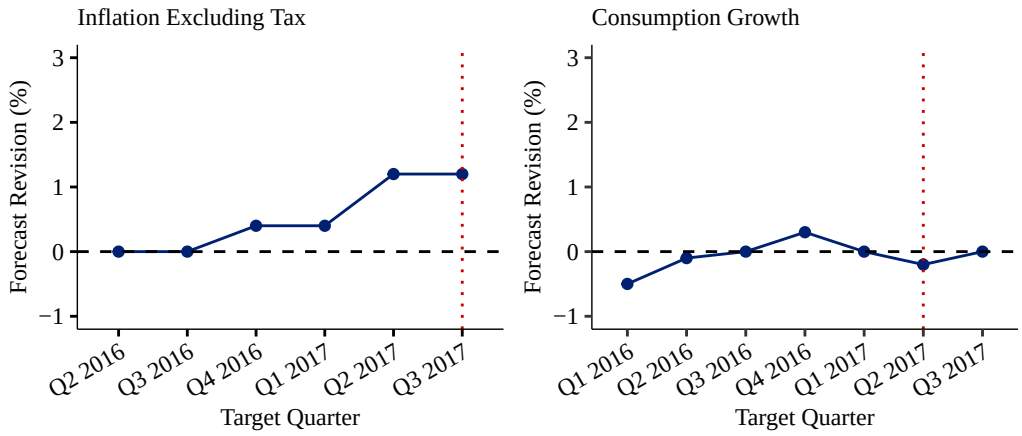
(b) Forecaster 2

Figure 10: Two Forecasters Anticipated the Postponement in April

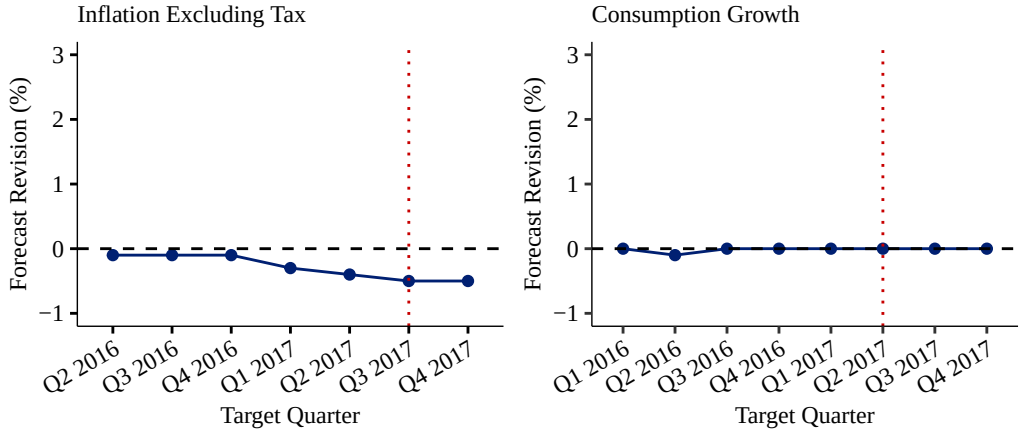
Note: The vertical red dotted line marks the timing at which the value-added tax hike was planned to take effect.

B.2 Forecasters Who Anticipated the Postponement in May

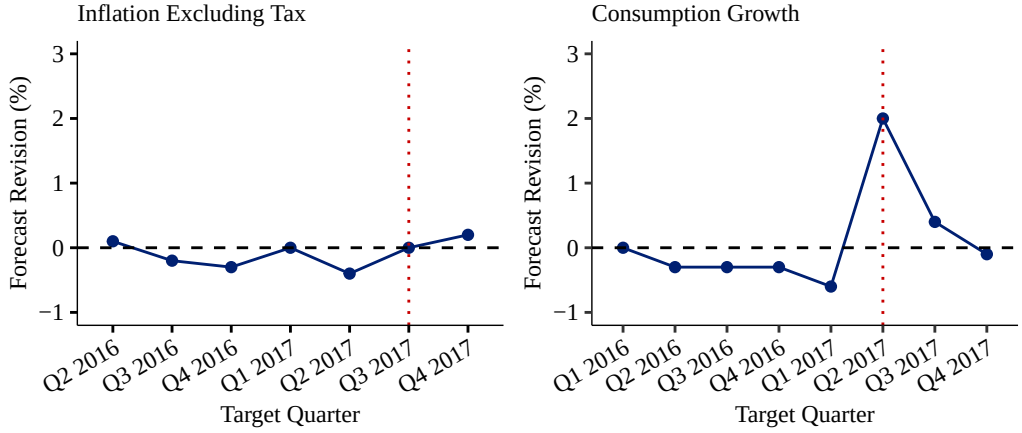
There are three forecasters who anticipated the postponement in May. We replicate the analysis from the previous subsection for these forecasters, computing forecast revisions from April to May. The results are shown in Figure 11. Once again, none of the forecasters revised their current inflation and consumption forecasts upward. However, for respondents C and D, we observe a notable difference: neither projected an increase in consumption growth in the second quarter of 2017. This suggests that they did not anticipate any pent-up demand in advance of the value-added tax hike. These heterogeneities are reflected in the forecaster fixed effects. While such heterogeneity in forecast revisions is noteworthy, the main conclusion remains unchanged: the expected inflation channel is weak.



(a) Forecaster 3



(b) Forecaster 4



(c) Forecaster 5

Figure 11: Three Forecasters Anticipated the Postponement in May

Note: The vertical red dotted line marks the timing at which the value-added tax hike was planned to take effect. Inflation forecast for the first quarter of 2016 are not submitted in May, as the corresponding inflation had already been released. This is why the inflation forecasts are drawn only from the second quarter of 2016.