Raising an Inflation Target: the Japanese Experience with Abenomics PRELIMINARY*

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Abstract

This paper draws from Japan's recent monetary experiment to examine the effects of increases in the inflation target when the economy is in a liquidity trap. We review Japanese data and examine through a VAR model how macroeconomic variables respond to identified inflation target shocks. We apply these findings to calibrate the effect of a shock to the inflation target in a new-Keynesian DSGE model of the Japanese economy. We argue that imperfect observability of the inflation target and a separate exchange rate shock are needed to successfully account for the behavior of nominal and real variables in Japan since late 2012. Our analysis indicates that Japan has made significant progress toward overcoming deflation, but further measures could help raise inflation to 2 percent in a stable manner.

KEYWORDS: Abenomics, Credibility, Deflation, Inflation target, Japan, Monetary policy.

JEL CLASSIFICATION: E31, E32, E47, E52, E58, F31, F41

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1 Introduction

This paper studies the effects of increases in the inflation target during a liquidity trap. To this end, we discuss Japan's recent aggressive monetary easing measures, including the adoption of a 2 percent inflation target in early 2013, and review the behavior of prices and exchange rates following this policy change. We then use a VAR to document that GDP and exchange rates respond more to inflation target shocks when the economy is in a liquidity trap. Finally, we use our empirical findings to calibrate a DSGE model of the Japanese economy that can account for the sluggish behavior of nominal and real variables in response to an inflation target shock. An important feature of our model is that agents update their estimates of the inflation target only gradually over time. As a consequence, consistent with Japanese data since 2012, inflation and inflation expectations rise very slowly after an increase in the target. Accordingly, changes in the inflation target, while powerful in a liquidity trap, can be weakened by the slow response of inflation.

A wide economic literature has documented the Japanese malaise of low economic growth and mild deflation, alongside high public debt and a rapidly aging population (e.g. Ito and Mishkin 2006). Figure 1 shows that Japanese inflation has been negative since the late 1990s. The emergence of deflation is generally attributed to the failure of policies conducted by the Bank of Japan (BOJ). Inflation is a monetary phenomenon, the argument goes, and the BOJ was unable to stop the inflation rate from turning negative. Many observers, including Krugman (1998) and Bernanke, Reinhart, and Sack (2004), have argued that the BOJ's efforts were too little and too late, calling for more aggressive and proactive measures. The aftermath of the global financial crisis provides a case in point. The BOJ lowered its policy rate to zero and expanded the size of its balance sheet. However, as the recovery stalled and deflation intensified, the BOJ came under criticism for the limited scope of its asset purchase program and for lacking conviction that its easing would yield tangible benefits.

Against this background, Mr. Shinzo Abe was elected Prime Minister in late 2012, running on an economic platform known as "Abenomics." Abenomics calls for ending Japan's long slump with three "arrows": aggressive monetary easing; flexible fiscal policy; and structural reforms (Eichengreen 2013, Ito 2013.) Even before coming into power, Mr. Abe started calling for a radical reorientation of monetary policy in November 2012. In February 2013, the BOJ introduced a new inflation target of 2 percent, though it refrained from pursuing significantly more aggressive easing. In April 2013, under the new leadership of Governor Haruhiko Kuroda, the BOJ unveiled a new policy package entitled "Quantitative and Qualitative Monetary Easing" (QQE.) The BOJ announced a sharp increase in purchases of Japanese government bonds (JGBs) and other assets, such as Japanese equity ETFs. The BOJ also extended the maturity of its JGB purchases. A goal of these measures was to double the monetary base in about two years. The BOJ also committed to continue these measures as long as necessary to achieve the 2 percent inflation target, though its stated aim was to get there by early 2015 (Kuroda 2013). Figure 2 shows that the BOJ's balance sheet has doubled in size since the introduction of QQE. To provide a reference point, the increase in the balance sheet of the BOJ during the first year of QQE (16 percent of Japanese GDP) nearly matches the total increase in the balance sheet of the Federal Reserve over the 5-year period from 2008 to 13 (18 percent of U.S. GDP).

Will aggressive monetary easing work? Expansionary monetary policies, including the announcement of an increase in the inflation target, might have negligible effects on actual inflation and inflation expectations unless they are fully credible. Japan's experience since the advent of Abenomics raises this concern. Longer-term inflation expectations have remained well below the 2 percent target, suggesting that private agents still doubt whether Abenomics will succeed. To better assess the risks, benefits and challenges of raising an inflation target, we analyze the the monetary regime change taking place in Japan today through the prism of two new-Keynesian models exhibiting inertial inflation behavior and imperfect credibility.

The remainder of the paper is organized as follows. Section 2 reviews how Japanese consumer prices, trade prices and exchange rates have evolved since the advent of Abenomics. Section 3 sets up a simple VAR model to examine what Japanese data over the past 40 years reveal about the real effects of changing an inflation target. Section 4 presents a theoretical analysis of an inflation target shock in a closed-economy, new-Keynesian model with inertial inflation behavior and imperfect credibility. Section 5 extend the previous analysis to an open-economy environment using the Federal Reserve staff's SIGMA model. Section 6 concludes.

2 Reflation, Prices and Exchange Rates in the aftermath of Abenomics

We see the adoption of the 2 percent inflation target as the cornerstone of Abenomics. We do not question here the optimality of this particular value. While several macroeconomic models indicate optimal inflation rates close to zero, other considerations have induced most central banks to prefer small but positive inflation rates. Kuroda (2013) gives two reasons for adopting a 2 percent target in Japan: mismeasurement of actual inflation, and risks of hitting the zero lower bound when inflation is low.

BOJ officials have appealed to a simple Phillips curve framework to justify why they need to increase their inflation target. Figure 7 shows estimates of Japan's Phillips curve, relating core inflation to a constant term and the output gap, over three sample periods. Following Shirai (2013), panel A is estimated over 1983Q1–2013Q2, panel B over 1983Q1–1995Q4, and panel C over 1996Q1–2013Q2, with C corresponding to the deflation period. In comparing panel B with panel C, the Phillips curve appears to have shifted down. The intercept term has fallen from 1.9 percent in the early period to -0.15 percent in the more recent period. Loosely speaking, the intercept identifies the steady-state rate of inflation that obtains when the output gap is closed. Accordingly, merely closing the gap might not be sufficient to raise inflation to 2 percent. Indeed, the estimated Phillips curve appears so flat that raising inflation to 2 percent would take an implausibly high output gap. Rather, the BOJ polices are aimed at shifting up the Phillips curve by resetting inflation expectations to a higher value.[1]

How much did inflation rise following the advent of Abenomics? As shown in Figure 1, total inflation rose to 1.5 percent in early 2014 from -0.2 percent in the fourth quarter of 2012. On this ground, Abenomics seems to have succeeded. However, a large component of the rise in total inflation appears to be transitory. Three pieces of evidence support

[1] Other studies, including Honda (2014) and Rogers and Wright (2014), have examined the effects of unconventional monetary policy in Japan. Rogers and Wright (2014) examine how asset prices are affected by unconventional monetary policy announcements. Typically, these studies have focused on the BOJ's asset purchases and have not considered economy-wide effects. A noticeable exception is the work of Hausman and Wieland (2014) who argued that Abenomics provided a substantial boost to Japanese output in 2013. In this paper, we expand this literature by investigating the transmission channels of raising an inflation target in a general equilibrium framework.

this claim. First, core inflation has remained below 1 percent. Second, a simple bivariate regression of total inflation on import price inflation attributes half of the recent increase in total inflation to higher import prices, which were in turn the result of a substantial depreciation of the yen (see Figure 4).[2] Third, consumer prices in categories which are not sensitive to exchange rate movements, such as housing and medical care, have hardly moved, as shown in Figure 3. Taken together, the evidence seems to indicate that Abenomics has thus far pushed up underlying domestic inflation by roughly 3/4 percentage point.

Inflation expectations have also moved up but have remained well below the 2 percent target. Following Hausman and Wieland (2014), we use 10-year inflation swap rates as our preferred measure of long-term inflation expectations.[3] Figure 5 shows that the swap rate has increased from nearly 1/2 percent in 2012 to 1–1/4 percent in early 2014. Although this measure is not ideal, it has increased by about the same amount as the 6- to 10-year ahead Consensus forecast. In addition, 10−year JGB yields have remained very low, trading near 60 basis points in early 2014, and 10−year forward rates are barely above 1 percent even at the end of 2016 (Figure 6). Inflation compensation is expected to remain very subdued well past the 2015 timeframe originally indicated by the BOJ for raising inflation to 2 percent. In sum, the available evidence suggests that long-term inflation expectations have risen, at most, by 1 percentage point.[4]

[2] We run a simple regression of total inflation on import price inflation and the output gap over the period 1992Q1-2012Q4. The regression results suggest that, over the 2012Q3–2014Q1 period, a 23 percent rise in import prices added roughly 3/4 percentage point to total inflation. This estimate likely provides a lower bound as imports of fossil fuels jumped up after Japan shut down its nuclear reactors following the Great East Japanese Earthquake and the Fukushima Daiichi nuclear disaster in March 2011, arguably contributing to render Japan consumer prices more sensitive to exchange rate fluctuations.

[3] As noted by Mandel and Barnes (2013), there is no ideal measure for inflation expectations in Japan. Break-even inflation measures are not reliable because the market for inflation-linked Japanese government bonds is very thin and a majority of the issuance has been bought back by the Ministry of Finance in recent years. Short-term measures of inflation expectations from surveys of households, investors, and professional forecasters appear to be more responsive to actual inflation than predictive of the future. Longer-term measures, such as the 6- to 10-year ahead inflation forecasts by Consensus, performed poorly over the past two decades, remaining close to 1 percent despite the emergence of deflation.

[4] See also Hausman and Wieland (2014)

3 VAR Evidence on Shocks to the Inflation Target

Do changes in the inflation target produce real effects? Ideally, one would like to identify in the data exogenous movements in the inflation objective of the central bank that are uncorrelated with other developments in the economy. In practice, such movements almost never occur. We then proceed by adopting an operational definition of what a change in inflation target should do, adapting the methodology developed by King, Plosser, Stock, and Watson (1991).

We formulate a 4-variable vector error correction model (VECM) with core inflation, detrended GDP, the long-term prime rate, and the real exchange rate.[5] To identify shocks to the inflation target, we impose the restriction that a change in the inflation target affects inflation and the interest rate by the same amount (percentagewise) in the long-run, but has no long-run effect on either GDP or the real exchange rate. This restriction might appear draconian, but it is implied by nearly all modern monetary business cycle models.

Figure 8 plots impulse response functions to the identified inflation target shock for the VECM estimated over two subperiods, 1974Q1-1996Q4 and 1992Q1-2012Q4. We choose these two samples to account for the different effects of inflation target shocks depending on whether short-term interest rates are at the effective zero lower bound or not. To facilitate the comparison between the two periods, we scale the plots so that the inflation target shock equals 2 percentage points. Such a shock corresponds to a 3 standard deviation shock in the early sample, when inflation in Japan was high and volatile, and, perhaps unsurprisingly, to a larger 6 standard deviation shock in the late sample, when inflation was low and relatively stable.

In both periods, the identified inflation target shock leads to a gradual and permanent increase in inflation and a temporary decline in real interest rates, as the nominal interest rate

[5] The real exchange rate is the log of the Trade Weighted Real Effective Foreign Exchange Rate (Haver series mnemonic: EERBR@JAPAN). The prime rate is the Long-term Prime Lending Rate (RILTP@JAPAN). We extract the business cycle component of real GDP (REDPC2@JAPAN) using a band-pass filter that selects frequencies between 2 and 32 quarters. Core inflation is the four-quarter change in the consumer price level, net of food and energy prices (S158PCXG@G10). Japan introduced a consumption tax of 3 percent in April 1989 and then raised it to 5 percent in April 1997. In order to remove the effect of these two hikes on consumer prices, we set the monthly inflation rate in April 1989 and April 1997 equal to the average monthly inflation over the other eleven months of the year, 1989 and 1997, respectively.

rises less than inflation. In turn, lower real rates stimulate economic activity, and GDP rises temporarily above the baseline. Lower real rates also lead to a temporary real depreciation. By construction, GDP and the real exchange rate both return to their initial baseline in the long run.

The comparison between the two periods reveals interesting differences. In the late sample, perhaps because short-term interest rates are effectively at zero, the response of the prime rate is more subdued, in spite of the more front-loaded increase in the inflation rate. Accordingly, the decline in the real rate is more pronounced. The depreciation of the yen is also substantially larger, and more persistent. In line with these findings, the boost to GDP is substantially larger in the late sample. To give some quantitative flavor, a 2 percent rise in the target leads to a rise in GDP of roughly 1/2 percent in the early sample, and to an increase of more than 2 percent in the late sample.

The results from the VAR analysis indicate that reflating the economy can bring short-run benefits in terms of output, and that these effects appear more pronounced when the economy is in a liquidity trap. However, taken at face value, this analysis also suggests the Bank of Japan needs to engineer an inflation shock that is 6 standard deviations above its mean over the last 20 years. This is a formidable challenge, especially in an environment where private agents might take only limited signal from movements in interest rates, which at shorter maturities remain constrained by the zero lower bound.

In Appendix A we confirm the plausibility of our identification scheme by showing results from an analogous VAR for U.S. data. The U.S. exercise also shows that inflation target shocks leads to a temporary depreciation of the exchange rate alongside a short-run increase in GDP.

4 The Effect of Inflation Target Shocks in a New-Keynesian Model

Section 3 showed how Japanese macroeconomic variables respond to identified inflation target shocks. We now continue our investigation by examining the effect of inflation target shocks in a standard closed economy new-Keynesian model. The model, a variant of a small-scale DSGE model in the tradition Christiano, Eichenbaum, and Evans (2005) and Smets and

Wouters (2007), features Calvo-style nominal price and wage rigidities, habit formation in consumption, investment adjustment costs, a fiscal authority, and a central bank that follows an interest rate rule subject to the zero lower bound. In most respects, the calibration of the model closely follows the estimated parameters in Smets and Wouters (2007). The main difference is that we choose a somewhat higher degree of price and wage rigidity (the Calvo parameters for prices and wages are respectively 0.95 and 0.925 at a quarterly frequency, and the indexation parameters are both equal to 0.8) to better characterize the slow and muted response of inflation to movements in the output gap that we documented in Figure 7. Additionally, we assume that the steady-state inflation rate is zero, and that the steady state nominal and real interest rate are both equal to 1 percent, assumptions that are in line with Japan's experience over the last two decades.

Households maximize a lifetime utility function given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\mathsf{a}_{ct} \log \left(c_t - \varepsilon_c c_{t-1} \right) - \frac{1}{1+\eta} n_t^{1+\eta} \right) \tag{1}$$

where c_t is consumption in period t, and n_t are hours worked. The term a_{ct} is a consumption preference shock. Their budget constraint is given by:

$$c_t + k_t + \phi_t = w_t n_t + \left(R_{kt} z_t + 1 - \delta \right) k_{t-1} + \mathrm{div}_t - \tau_t - b_t + \frac{R_{t-1}}{\Pi_t} b_{t-1} \tag{2}$$

where k_t is capital, ϕ_t denotes convex investment adjustment costs,[6] $w_t n_t$ is wage income, $\left(R_{kt} z_t + 1 - \delta \right) k_{t-1}$ is capital income (and z_t is the variable capital utilization rate), div_t are dividends from ownership of sticky price and wage firms, τ_t are lump-sum taxes levied by the government, b_{t-1} is one-period government debt, which pays a gross nominal interest R_{t-1}, and Π_t is the one-period gross inflation rate.

The economy–wide production function takes the form:

$$Y_t = n_t^{1-\mu} \left(z_t k_{t-1} \right)^{\mu} . \tag{3}$$

[6] Investment adjustment costs take take the form $\phi_t = \phi \left(i_t - i_{t-1} \right)^2 / \bar{i}$, where $\bar{i}$ is steady-state investment and investment and capital are linked by $k_t = i_t + (1-\delta) k_{t-1} - \phi_t$.

where μ is the capital share. Additionally, the presence of monopolistic competition in the goods and labor markets, coupled with staggered nominal adjustment *à la* Calvo, results in two standard price and wage Phillips curves. We assume that firms that do not adjust their prices index them to the previous period inflation rate.

The government levies lump-sum taxes which respond to beginning of period debt, and buys g_t as a constant fraction of the final output each period. The economy-wide market clearing condition is

$$Y_t = c_t + i_t + g_t. \tag{4}$$

The behavior of the central bank is characterized by a Taylor rule subject to the ZLB constraint:

$$r_t = \max\left(0, \phi_r r_{t-1} + (1-\phi_r)\left(rr + \pi_t + \phi_\pi\left(\pi_t - \pi_t^*\right) + \frac{\phi_y}{4}\widetilde{y}_t\right) + e_t\right) \tag{5}$$

where $r_t = R_t - 1$ is the net nominal interest rate, $\pi_t = \Pi_t - 1$ is the net inflation rate, $\phi_r = 0.75$ is the inertial coefficient in the rule, rr is the steady state real interest rate, equal to 1 percent on an annual basis, $\phi_\pi = 0.5$ is long-run response coefficient of the real rate to inflation, and $\phi_y = 0.5$ is the response to the output gap $\widetilde{y}_t$ (here defined as output relative to its steady state). Finally, π_t^* is a very persistent monetary shock, whereas e_t is a transient monetary policy shock which captures short-run deviations of the interest rate from its historical rule. Formally:

$$\begin{bmatrix} \pi_t^* \\ e_t \end{bmatrix} = \begin{bmatrix} 0.999 & 0 \\ 0 & 0.001 \end{bmatrix} \begin{bmatrix} \pi_{t-1}^* \\ e_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{pt} \\ \varepsilon_{qt} \end{bmatrix} \tag{6}$$

where ε_{pt} and ε_{qt} are normal iid innovations with variances σ_p^2 and σ_q^2 respectively. As in Erceg and Levin (2003), the linear combination of these two shocks, given by $Z_t = e_t - (1-\phi_r)\,\phi_\pi \pi_t^*$, identifies the central bank's time-varying inflation target.

The properties of this model in response to e_t and π_t^* shocks are, of course, well known, especially outside of the ZLB, as studied for instance in Erceg and Levin (2003) and Ireland (2007). A temporary *reduction* in e_t lowers nominal interest rates. With sticky prices, however, the real rate falls. Thus, aggregate demand and output rise, and inflation increases temporarily above the baseline. An *increase* in π_t^* leads to a persistent increase in inflation. As the nominal interest rate only slowly increases, the real rate falls, again stimulating output and aggregate demand. Eventually, if the change in π_t^* is assumed to be permanent, the change in the target will have (almost) no effects on the real variables, and the nominal interest rate will rise one-for-one with inflation and with the target itself.[7] All else equal, for given change in the nominal interest rate relative to what the Taylor rule would prescribe, a change in π_t^* has a more powerful effect on the economy than a change in e_t, since it signals the intention of the central bank to keep interest rate lower for longer.

These effects are also present at the ZLB. Changes in e_t may have either little (if they are large enough) or no effects on the policy rate, since they affect only the notional interest rate,[8] but are unable to affect r_t when $r_t = 0$ and the economy is in a liquidity trap. By contrast, increases in π_t^* can have powerful expansionary effects on the economy as the central bank keeps, on average, lower interest rates for longer because of the ZLB. Figure 9 illustrates these results for a very persistent change in the target (autocorrelation of 0.999). To match Japan's context, we assume a baseline where a sequence of negative demand shocks (triggered by a sequence of negative realizations of a_{ct}) lowers output and is expected to keep the policy rate at zero until year 2017, and report all the variables in deviation from such baseline. We then assume that a sequence of shocks to π_t^* over the 2012Q4-2013Q2 bring the inflation target from 0 to 2 percent: this sequence mimics events the monetary policy regime change set in motion by Abenomics, as discussed in Section 2. A 2 percentage point increase in the target boosts GDP by about 1.5 percent after two years, before GDP slowly returns to the baseline. The driver for the rise in GDP is the decline in real rates which is further boosted by the fact that interest rates are kept at zero for a long period. By contrast, under a baseline where interest rates are not constrained by the ZLB, although the response of inflation is similar, output rises less since nominal rates respond sooner to the higher inflation rate. In both experiments, even if prices are assumed to be very sticky, inflation rises above 1.5 percent in less than two years and reaches its target after three years,

[7] This is true insofar as the long-run Phillips curve is vertical, which is almost true in the standard new-Keynesian model.

[8] The notional interest is the rate that would prevail were the zero lower bound on the interest rate not present.

while long-run inflation expectations immediately jump and remain anchored to the new, 2 percent target.

The fast response of inflation and inflation expectations following a change in the target in Figure 9 appears at odds with our reading of recent experience of Japan. As discussed in Section 2, we think that Abenomics pushed up underlying domestic inflation by only 3/4 percentage points and long-term inflation expectations by, at most, 1 percentage point. Other studies, Hausman and Wieland (2014) also point out that the BOJ's 2 percent target is not yet fully credible. In light of this, we therefore proceed by modifying the model to allow for imperfect observability of the inflation target itself, following Erceg and Levin (2003). In particular, we assume that agents have perfect knowledge of all the aspects of the model, including the reaction function of the central bank in absence of the zero lower bound. However, agents can only observe the sum of the persistent and transitory monetary shocks Z_t, and infer their individual components solving a signal extraction problem. Figure 10 compares the perfect credibility case with the case in which agents revise their expectations about the persistent component of the monetary shock only slowly over time. We set the signal-to-noise ratio so that the half-life of the perceived inflation target is about two years. This assumption better lines up with the actual experience of Japan since Abenomics, as discussed above. Under imperfect credibility, inflation rises much more slowly, the decline in the real rate is less pronounced, and the increase in GDP is accordingly more muted.

One way to break out from the slow increase in inflation would be to make a much bolder statement about the inflation target itself. For instance, one possibility would be to temporarily adopt an inflation target higher than 2 percent. In Appendix B, we examine the benefits and also the possible costs of such bolder actions, by assuming that higher inflation prompts a decline in real rates (benefits) alongside a an increase in risk premia (costs). We show that in such a scenario an increase in the inflation target may lead to a decline in GDP and, through higher borrowing costs, to a higher public debt-to-GDP ratio.

5 Inflation Target Shocks in the SIGMA Model

One obvious limitation of the model in the previous section is that it lacks open economy considerations. However, as the exchange rate behavior in the VAR in Section 3 underscores, open economy considerations may be an important channel of transmission of inflation target shocks in the Japanese economy. Accordingly, in this Section we assess the transmission mechanism of shocks to the inflation target using a version of the Federal Reserve staff's forward-looking, multicountry, dynamic general equilibrium model, SIGMA. We conduct our simulations in a three-country version of SIGMA that includes the United States, Japan, and an aggregate "rest of the world" (ROW) block comprised of all other foreign countries. The properties of the model are described in Erceg, Guerrieri, and Gust (2006). As in the model of the previous Section, we assume a baseline where Japan is expected to be in a liquidity trap until 2017.

Studying inflation dynamics using SIGMA allows us to quantify the role of both domestic and foreign sources of inflation. An important feature of SIGMA is the assumption that producers in each country are assumed to set prices in the local buyers' currency, but are subject to Calvo-style price rigidities in doing so. We choose a calibration of SIGMA that assumes that Japanese exporters (to the United States and ROW) change their prices very infrequently, whereas U.S. and ROW exporters (who export to Japan) adjust their prices relatively more frequently. This assumption captures the behavior of Japanese import and export prices in the aftermath of the large depreciation of the yen occurred since the beginning of Abenomics. As shown in Figure 4, Japanese import prices (in yen) have risen one-for-one with the weaker yen, thus indicating a large pass-through.[9] Japanese export prices (measured in yen) have also risen nearly one-for-one, but this result suggests limited pass-through on the export side. To the extent that changes in the inflation target affect exchange rates, the degree of pass–through from exchange rates to trade prices should in turn affect the response of net exports and GDP.

A fully credible inflation target shock in SIGMA produces substantially larger effects on

[9] Shimizu and Sato (2014) show that in recent years Japanese manufacturing export prices in terms of the invoice currency (typically the U.S. dollar) responded little to exchange rate fluctuations, concluding that the long-run effect of yen depreciation has weakened.

GDP and on inflation when the economy is a deep liquidity trap. Figure 11 shows that, at the ZLB, GDP rises about 3 percent above the baseline when the inflation target is raised to 2 percent, whereas the corresponding increase without the ZLB would be less than 1 percent. The large rise in GDP at the ZLB is made possible by the fact that interest rates are unchanged for several years after the shock. In turn, lower interest rates throughout the duration of the liquidity trap lead, through the UIP condition, to a large depreciation of the yen on impact. In addition, the dynamics of total (domestic and imported) inflation are affected in important ways by the behavior of the exchange rate. On impact, the large impact depreciation causes a surge in import prices and, in turn, in total inflation. As the short-run boost to import prices dies out, both import price inflation and total inflation decline in the medium run before slowly converging to their 2 percent target. The large responses of output and the real exchange rate when the economy is in a liquidity trap mirror the evidence in the VAR that inflation target shocks produce larger real effects in the 1992-2012 sample compared to the 1974-1996 one.

One drawback of the model with perfect observability of the target is that inflation expectations jump too quickly following a change in the inflation target. Accordingly, we proceed by introducing in SIGMA imperfect observability of the inflation target, following the same approach as in Section 4. Figure 12 shows the model dynamics when the signal-to-noise ratio is calibrated so that long-term expected inflation gradually rises to one percent in about two years relative to baseline, thus mirroring the actual behavior of expected inflation in the data documented in Section 2. All told, the gradual rise in inflation curbs the decline in real interest rate and thus the output response.

Regardless of what one assumes about the credibility of changes in the inflation target, it is of independent interest to offer a more complete account of the probable real effects of Abenomics when we calibrate the model in order to simultaneously match both the change in inflation expectations and the actual depreciation of the yen that took place between late 2012 and early 2014. In Figure 13 we combine the inflation target shock with an exogenous increase in the risk premium on home-currency-denominated assets so to generate a 15 percent depreciation of the real yen index. In the imperfect credibility case, the two shocks combined yield a rise in GDP relative to the baseline of about 4 percent. On impact, inflation jumps to 2 percent as soon as the higher inflation target is announced. However, as the one-off effect of the yen's depreciation dissipates, total inflation recedes to about 1 percent before slowly rising to its higher target.

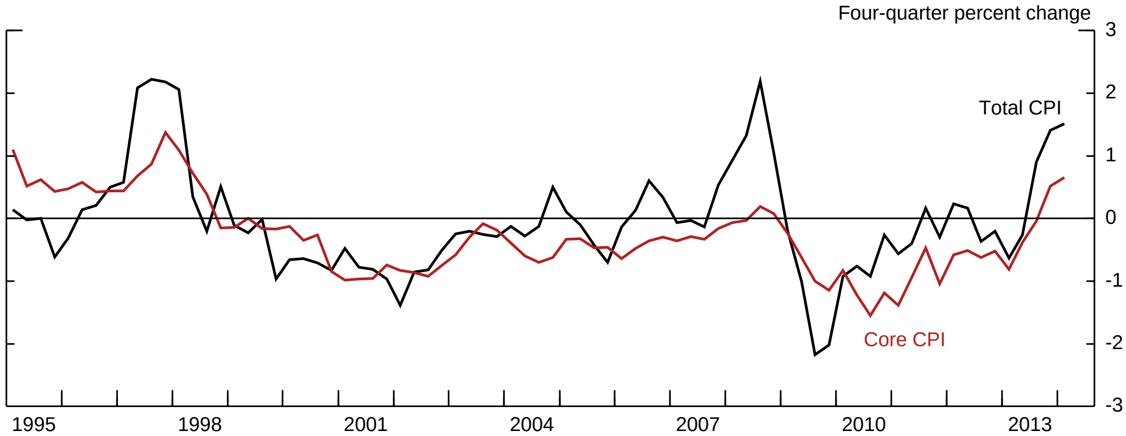
6 Conclusions

Every big change in policy confronts policymakers with a credibility issue. The Bank of Japan may face such a problem now, and further bold actions could be needed to raise inflation to 2 percent in a stable manner.

The arguments presented in this paper formalize, using the framework proposed by Erceg and Levin (2003), the "timidity trap" recently illustrated by Krugman (2014): "But what does it take to credibly promise inflation? Well, it has to involve a strong element of self-fulfilling prophecy: people have to believe in higher inflation, which produces an economic boom, which yields the promised inflation. But a necessary (not sufficient) condition for this to work is that the promised inflation be high enough that it will indeed produce an economic boom if people believe the promise will be kept."

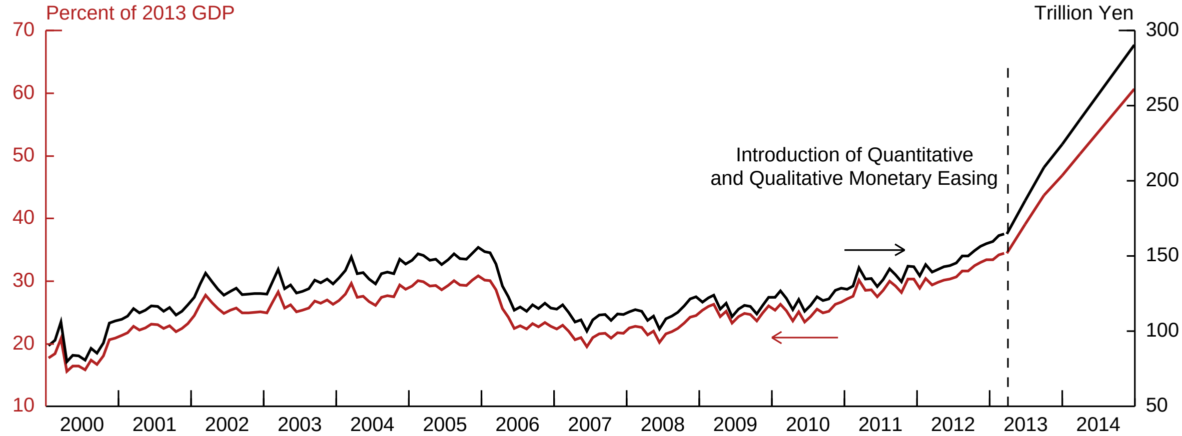
We conclude by highlighting two directions for future work. First, our analysis assumes that the degree of credibility of a central bank is given and exogenous. A natural extension of our analysis would be to examine what steps a central bank can take to improve the credibility/observability of a new inflation target, following insights from the monetary policy commitment literature (Schaumburg and Tambalotti 2007). Second, structural reforms – one of the stated goals of Abenomics – could exert deflationary pressures (Eggertsson, Ferrero, and Raffo 2014) which may undermine the effects of increasing the inflation target; jointly studying the credibility of both reforms and changes in the target would be an interesting avenue for future research.

Figure 1: Core and Headline Inflation in Japan



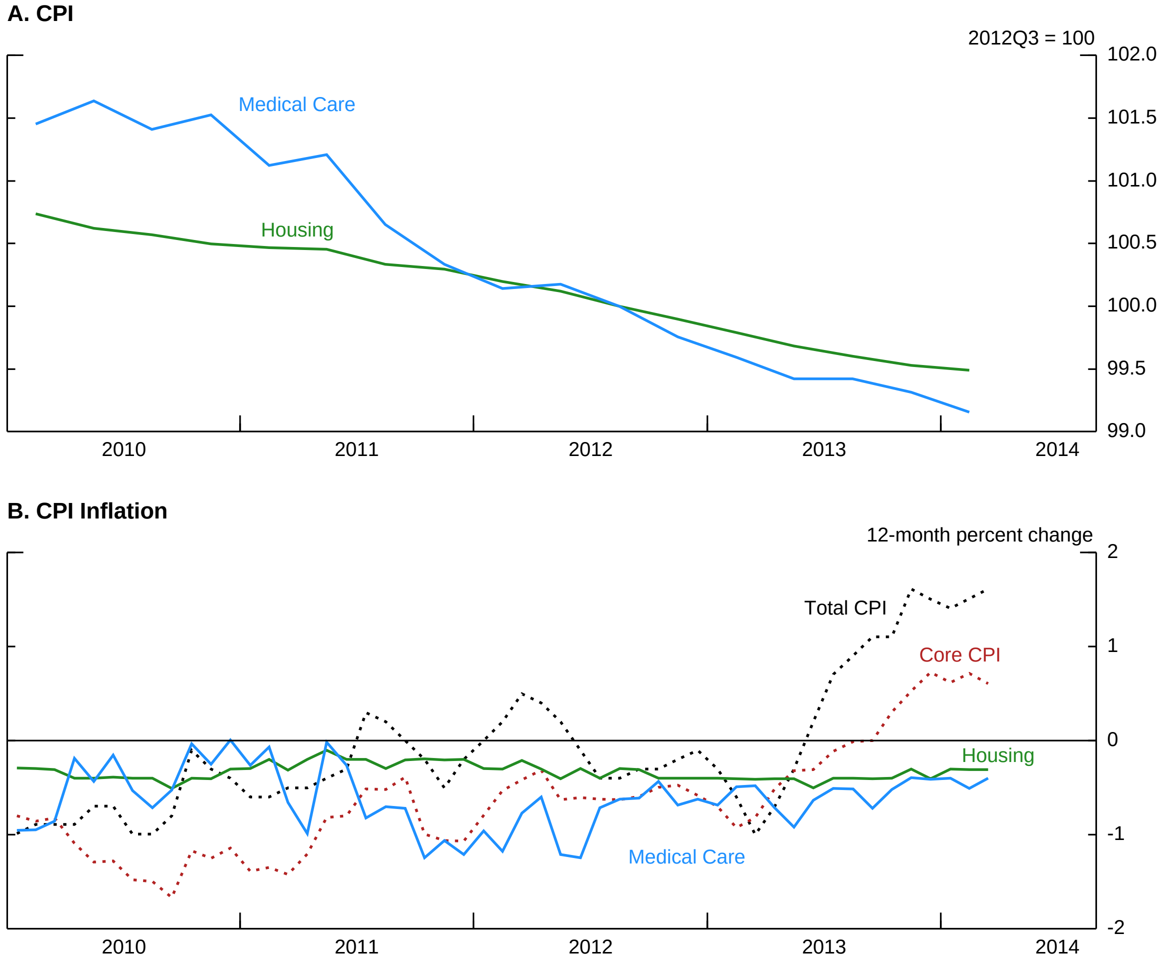
Note: The source of the data is Haver Analytics. The Haver mnemonic for the Total CPI series is CIJ102@JAPAN. The Core CPI (excluding food and energy prices) is based on the Haver series S158PCXG@G10. From the Core CPI series, we removed the effects of the 3 consumption tax Japan introduced in April 1989 and then raised to 5 percent in April 1997. We set the monthly core inflation rate for April 1989 and April 1997 equal to the average monthly inflation over the other eleven months of the year, 1989 and 1997, respectively.

Figure 2: QQE in Japan: BOJ Balance Sheet



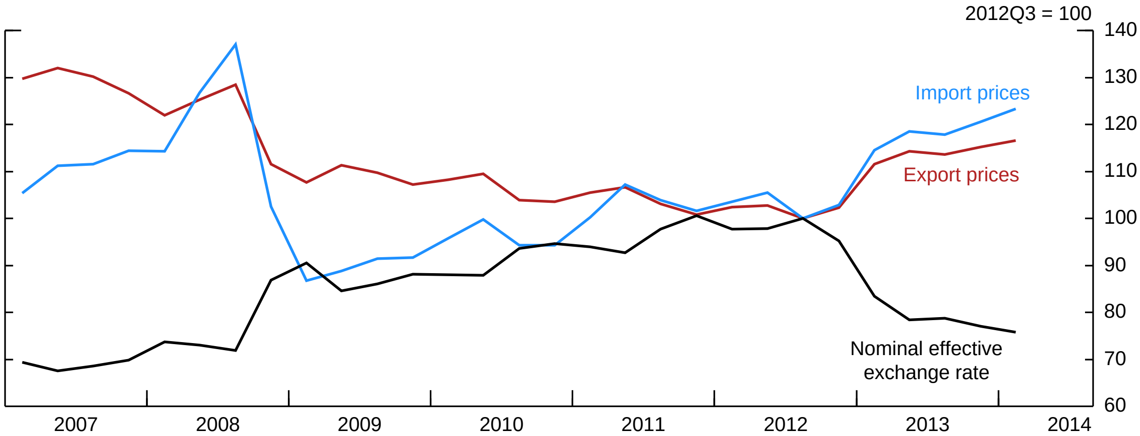
Note: Data are from Haver Analytics and the Bank of Japan. Data after 2014Q1 are based on the BOJ's announcement of its Quantitative and Qualitative Monetary Easing program on April 4, 2013

Figure 3: Housing and Medical Care Prices



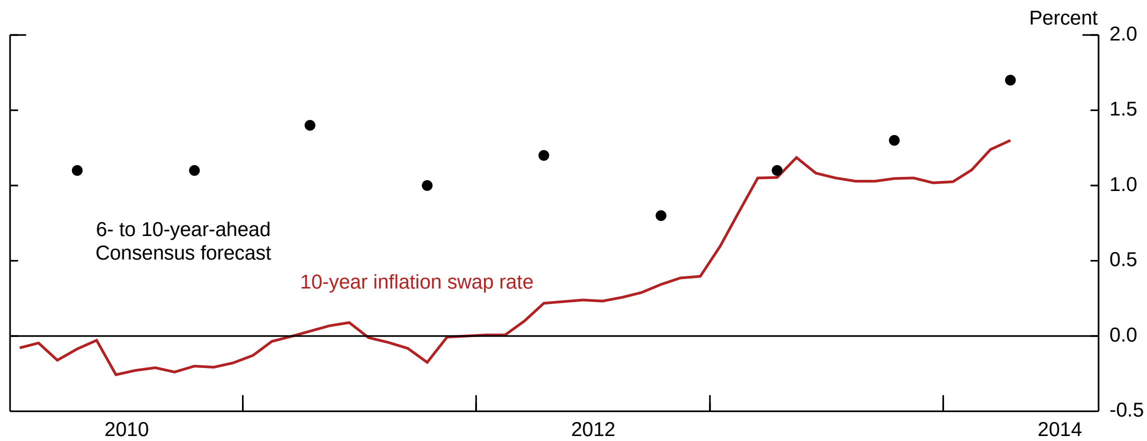
Note: The source of the data is Haver Analytics. The Haver mnemonic for Medical Care is CIJMC10@JAPAN and for Housing CPI CIJH10@JAPAN.

Figure 4: Yen, Export Prices, and Import Prices



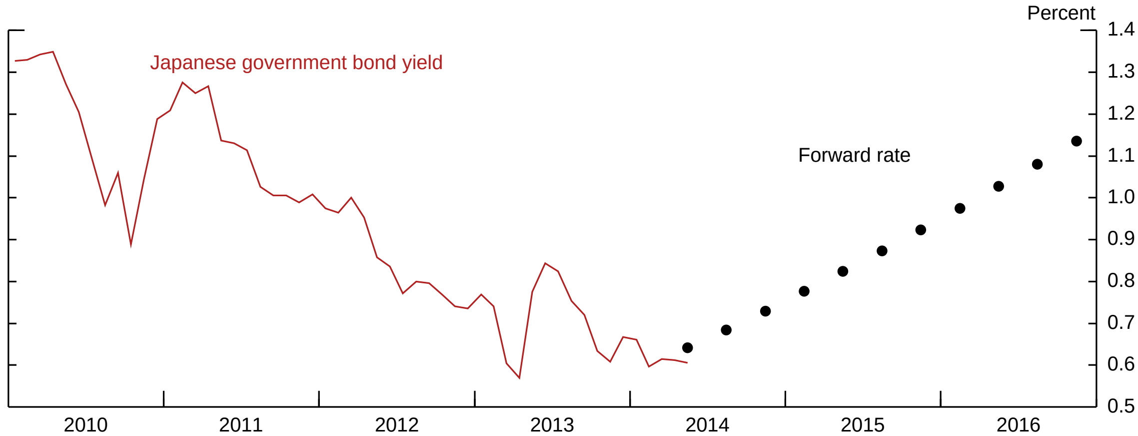
Note: The source of the data is Haver Analytics. The nominal effective exchange rate is the Bank of International Settlement's Trade Weighted Nominal Effective Foreign Exchange Rate (EERBN@JAPAN). The yen export price series is EPYA10@JAPAN and the yen import price series is IPYA10@JAPAN.

Figure 5: Inflation Expectations



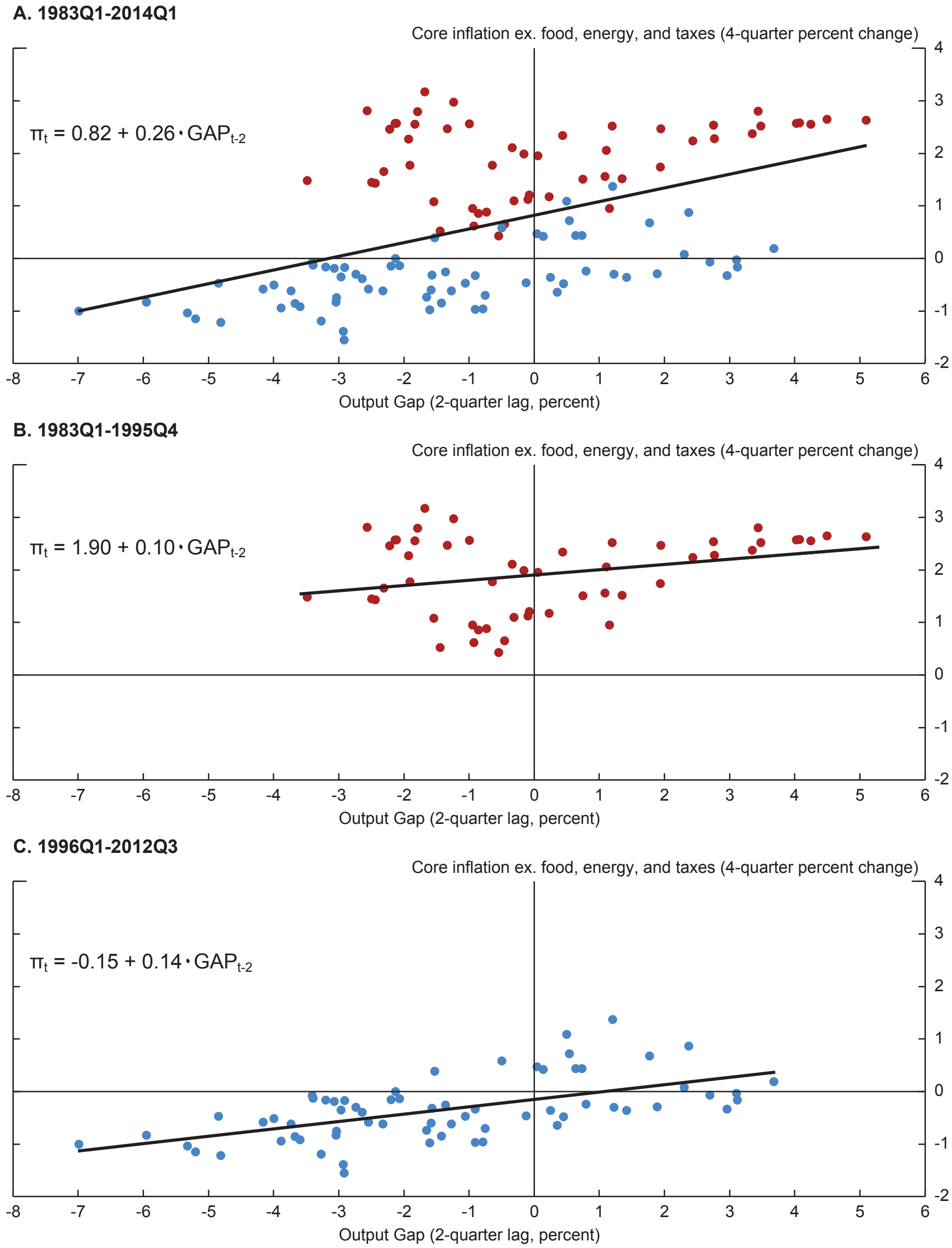
Note: The source of the data are Bloomberg and Consensus Economics. The Bloomberg's ticker for the inflation spaw rate is JYSWIT10 Curncy.

Figure 6: Ten-Year Rate



Note: The source of the data is Haver Analytics. The 10-year benchmark Japanese government bond yield by the Ministry of Finance corresponds to the series JPNGA@JAPAN. The Japanese 10-year forward rate is estimated by the Federal Reserve Board staff.

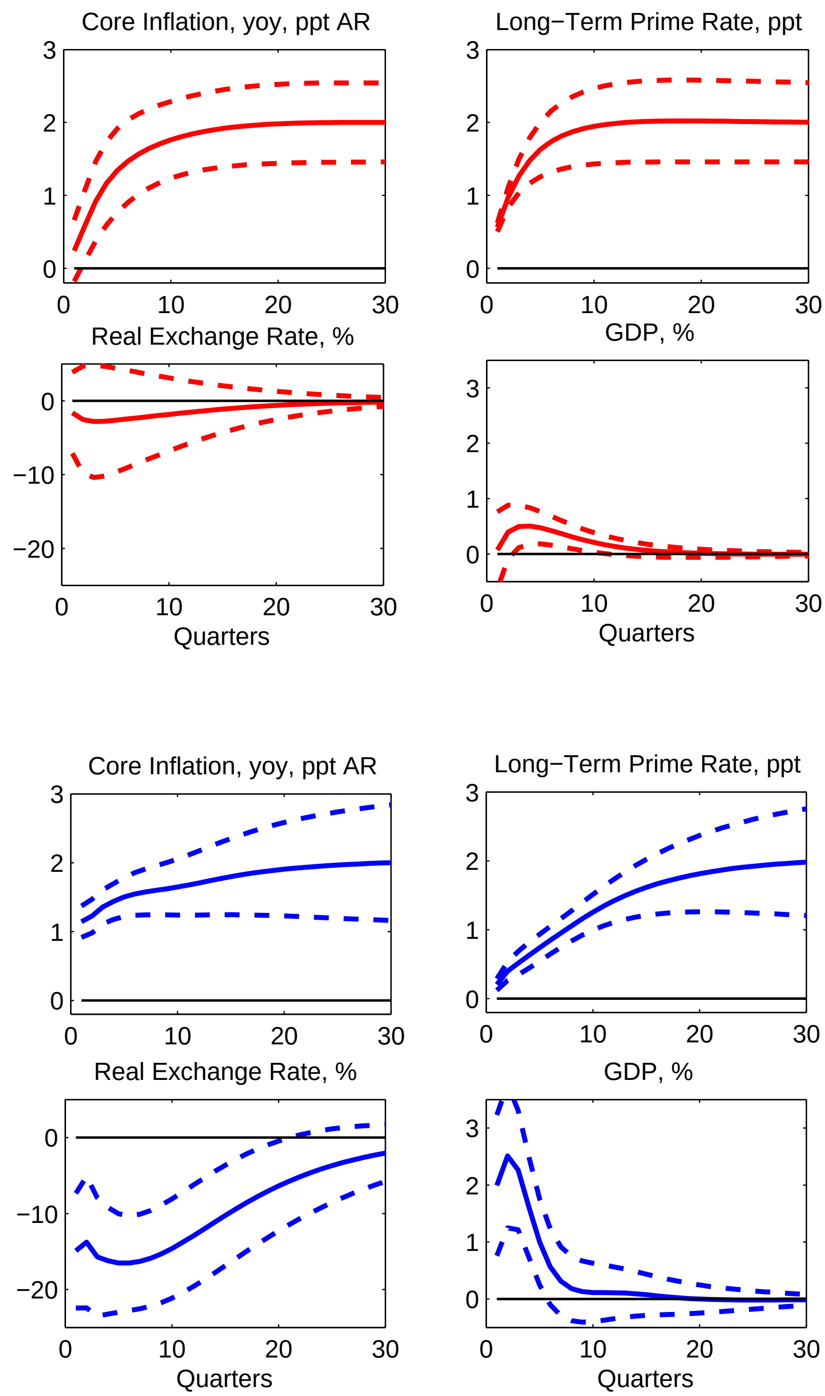
Figure 7: Phillips Curves



Source: OECD output gap from Economic Outlook database 90. Core inflation is four-quarter change in the consumer price level, net of consumption tax changes and food and energy prices (Haver series mnemonic S158PCXG@G10 and authors' calculations).

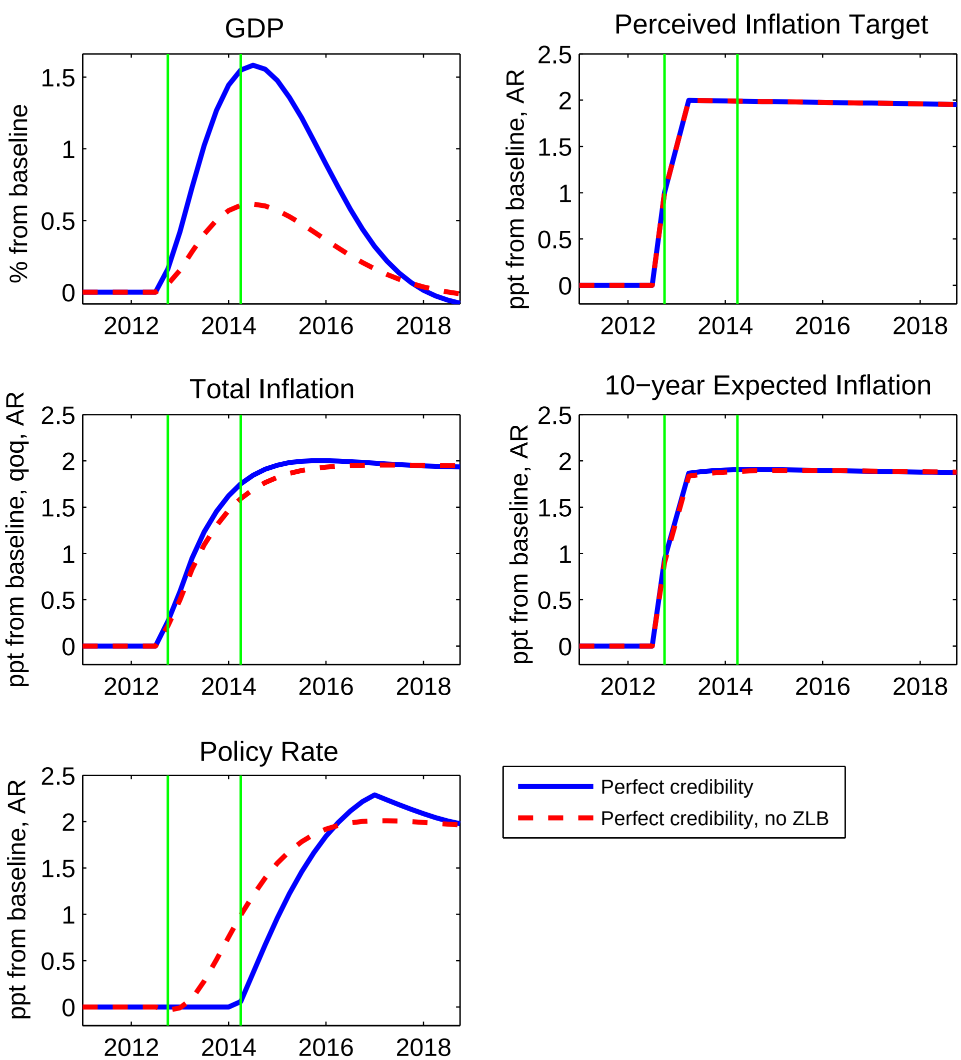
Note: The source of the data are Haver Analytics and the OECD. Core inflation is four-quarter change in the consumer price level, net of consumption tax changes and food and energy prices (Haver series mnemonic S158PCXG@G10 and authors' calculations. The output gap is from the OECD Economic Outlook database 90. The three equations on the left side of the three panels report the results of a simple regression of the core inflation over a constant term and the 2 -quarter lagged output gap. All estimated coefficients are statically significant at the 95 percent level.

Figure 8: Inflation Target Shocks: VAR Evidence for Japan in Two Sample Periods



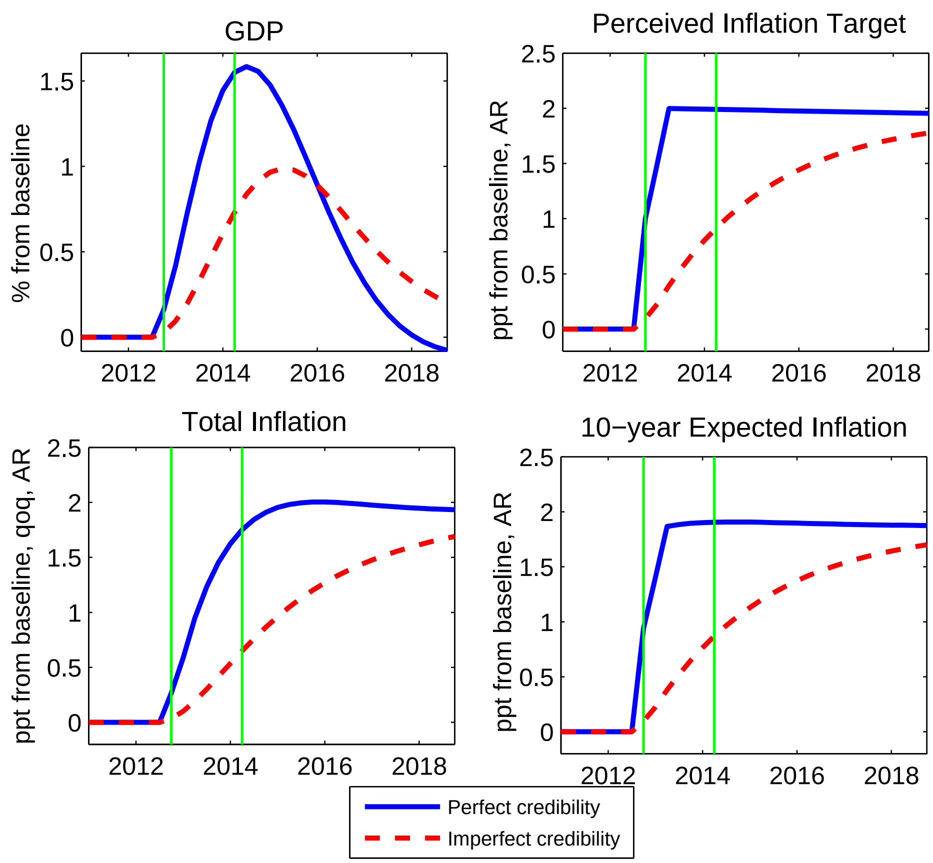
Note: The top four panels plot the impulse responses (together with one s.e. bands) to a 2 percentage point inflation target shock (3 standard deviations) in the early sample (1974Q1-1996Q4). The bottom four panels plot the impulse responses to a 2 percentage point inflation target shock (6 standard deviations) in the late sample (1992Q1-2012Q4).

Figure 9: NK Model. Change in Inflation Target: ZLB vs No ZLB



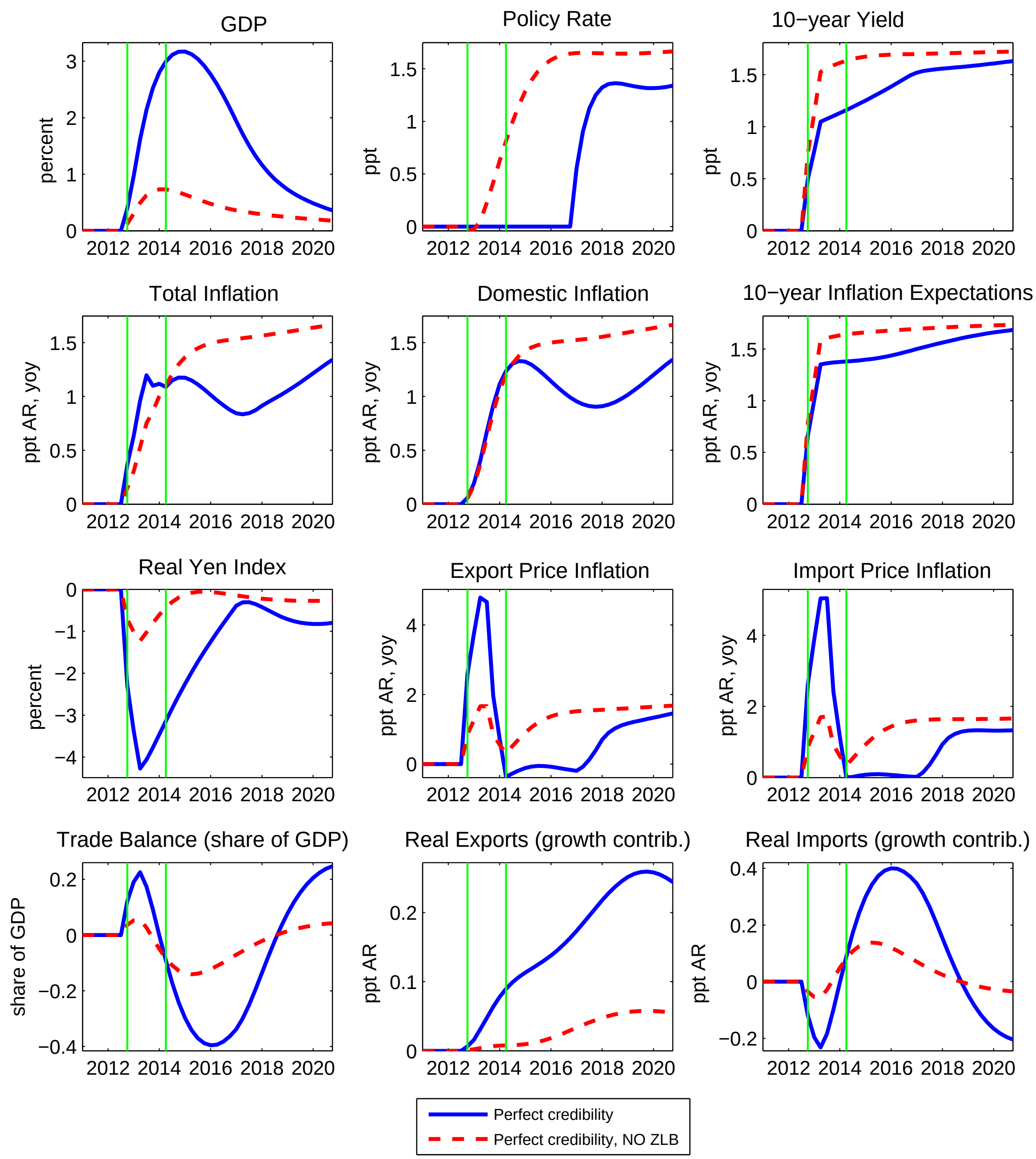
Note: The lines plot the impulse response to a 2 percentage point inflation target shock. The shock takes place over three periods (2012Q4-2013Q2). The solid lines plot the benchmark responses against a baseline where the policy rate is expected to be at zero until 2016Q4. The dashed lines plot the responses when the policy rate is not constrained by the zero lower bound (ZLB). The first vertical green line identifies the start of Abenomics (2012Q4) and the second one corresponds to today (2014Q2).

Figure 10: NK Model. Change in Inflation Target: Perfect vs Imperfect Credibility



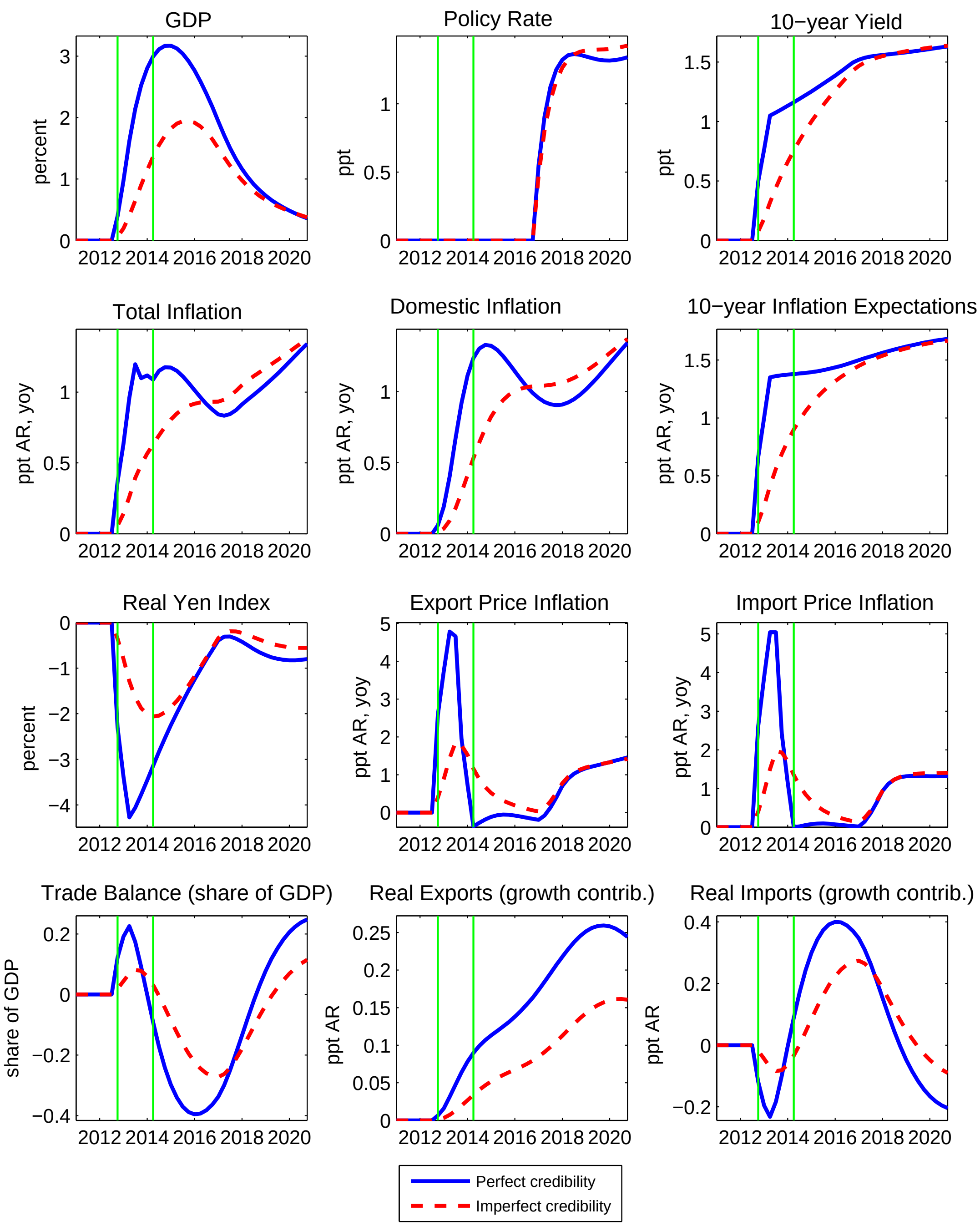
Note: The lines plot the impulse response to a 2 percentage point inflation target shock. The shock takes place over three periods (2012Q4-2013Q2) against a baseline where the policy rate is expected to be at zero until 2016Q4. The solid lines plot the benchmark case when agents have full information about the change in the inflation target. The dashed lines plot the responses when the inflation target is imperfectly observed. The first vertical green line identifies the start of Abenomics (2012Q4) and the second one corresponds to today (2014Q2).

Figure 11: SIGMA Model. Change in Inflation Target: ZLB vs No ZLB



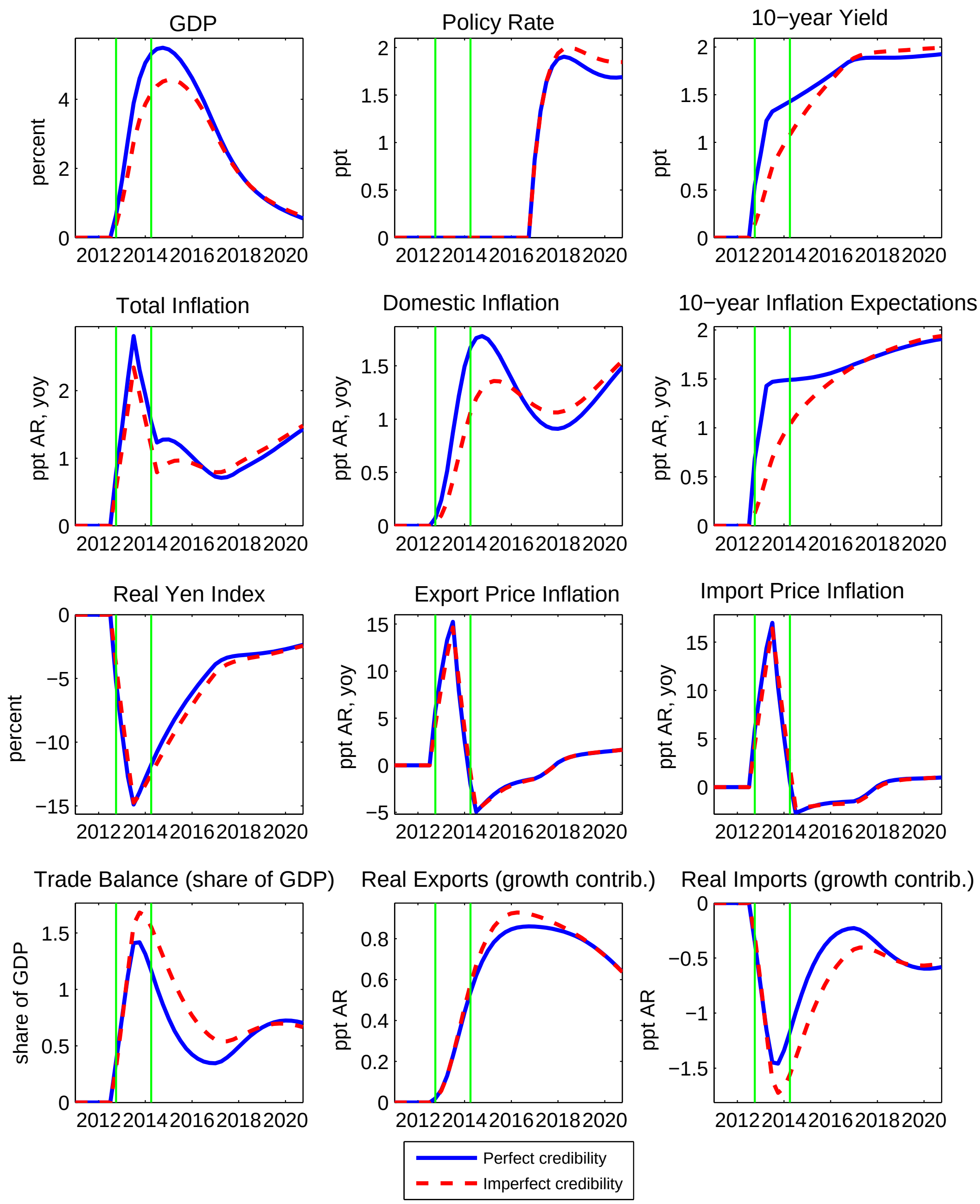
Note: The lines plot the impulse response to a 2 percentage point inflation target shock. The shock takes place over three periods (2012Q4-2013Q2). The solid lines plot the benchmark responses against a baseline where the policy rate is expected to be at zero until 2016Q4. The dashed lines plot the responses when the policy rate is not constrained by the zero lower bound (ZLB).

Figure 12: SIGMA Model. Change in Inflation Target: Perfect vs Imperfect Credibility



Note: The lines plot the impulse response to a 2 percentage point inflation target shock. The shock takes place over three periods (2012Q4-2013Q2) against a baseline where the policy rate is expected to be at zero until 2016Q4. The solid lines plot the benchmark case when agents have full information about the change in the inflation target. The dashed lines plot the responses when the inflation target is imperfectly observed.

Figure 13: SIGMA Model. Change in the Inflation Target and Exchange Rate Shock



Note: The lines plot the impulse response to a 2 percentage point inflation target shock coupled with a risk premium shock that leads to a 15 percent depreciation of the real yen index. The shock takes place over three periods (2012Q4-2013Q2) against a baseline where the policy rate is expected to be at zero until 2016Q4. The solid lines plot the benchmark case when agents have full information about the change in the inflation target. The dashed lines plot the responses when the inflation target is imperfectly observed.

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Appendix

Appendix A Robustness Analysis on the VAR

In Section 3 we show how Japanese macroeconomic variables respond to an inflation target shock using a structural VAR. The identified shock leads to a permanent increase in inflation and nominal interest rates and causes a short-lived expansion in economic activity alongside a temporary depreciation of the currency. In this Section we validate the robustness of our VAR results by applying the same identification restrictions to a VAR on U.S. data for the period 1970:1–2013:4. As before, we formulate a 4-variable vector error correction model (VECM) with inflation, detrended GDP, the long-term interest rate, and the real exchange rate.[10] Our VAR includes a constant and four lags of each variable.

Figure A.1 plots the impulse response to the identified inflation target shock for the U.S. When the shock is normalized so that it leads to a 2 percent long-run increase in inflation (corresponding approximately to a 3 standard deviations shock), it leads to a temporary decrease in real interest rates, to a depreciation of the exchange rate (about 4 percent after one year), and to a short-run boost in economic activity. In the first year after the shock, GDP is about 1.25 percent above the baseline, somewhere in between the response of GDP in Japan for the two sub-samples.

Appendix B Risk Premia

Section 4 and 5 showed that the dynamics under imperfect credibility seem to capture reasonably well the recent Japanese experience. However, they also imply that inflation will rise to 2 percent very slowly going forward, rasing the question of what the BOJ could do to achieve sooner its goal. One way to break out from this slow adjustment would be to make a much bolder statement about the inflation target itself. For instance, one possibility would be to temporarily adopt an inflation target higher than 2 percent, a scenario we explore using the closed-economy model developed in Section 4. In Figure A.2, we show the responses to an additional boost in the inflation target from 2 to 3 percent between 2014Q2 and 2015Q4. Following the announcement, the inflation target perceived by the agent rise

[10] The real exchange rate is the JP Morgan Broad Real Effective Exchange Rate Index for the United States, log transformed (Haver mnemonic: N111XJRB@G10). The long-term interest rate is the 10-Year Treasury Note Yield at Constant Maturity (FCM10@USECON). Inflation is the four-quarter change in the consumer price level net of food and energy (S111PCXG@G10). Finally, we extract the business cycle component of real GDP (GDPH@USECON) using a band-pass filter that selects frequencies between 2 and 32 quarters.

much faster. Accordingly, inflation immediately accelerates and approaches 2 percent by the end of 2015, much earlier than in the previous case. The resulting lower real rates also provide an additional lift to GDP.

There may be risks associated with such bolder policies, including the possibility that inflation might get out of control. Given Japan's precarious public finances –net debt is approaching 150 percent of GDP– some observers (e.g Eichengreen 2013) have discussed the possibility that a misstep in the direction of substantially higher inflation might induce investors to think that fiscal objectives have come to dominate monetary policy, triggering a self-fulling vicious cycle of destabilizing inflation and debt dynamics. In other words, fears of fiscal dominance or debt monetization might materialize in case of large enough inflation surprises, prompting a jump in risk premia. To explore such a scenario, we modify our benchmark new-Keynesian model and allow for risk premia on government debt which are triggered by increases in the inflation rate above a certain threshold. More specifically, we re-write the budget constraint, equation (1), as:

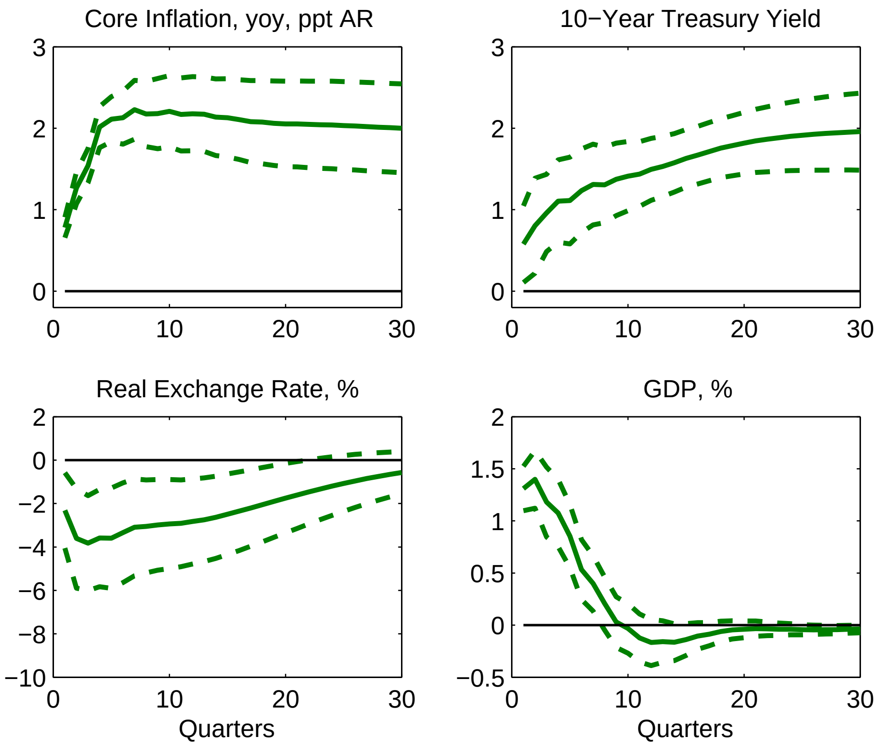
$$c_t + k_t + \phi_t = w_t n_t + \left(R_{kt} z_t + 1 - \delta\right) k_{t-1} + \mathrm{div}_t - \tau_t - b_t + \frac{\widetilde{R}_{t-1}}{\pi_t} b_{t-1} \tag{7}$$

where the gross interest on government debt $\widetilde{R}_{t-1} = R_{t-1} + \varepsilon_t$ and the risk premium ε_t follows:

$$\varepsilon_t = \begin{cases} \alpha\left(\pi_t - \pi_{t-1}\right) & \text{if } \pi_t - \pi_{t-1} > \lambda \\ 0 & \text{if } \pi_t - \pi_{t-1} \leqslant \lambda \end{cases} \tag{8}$$

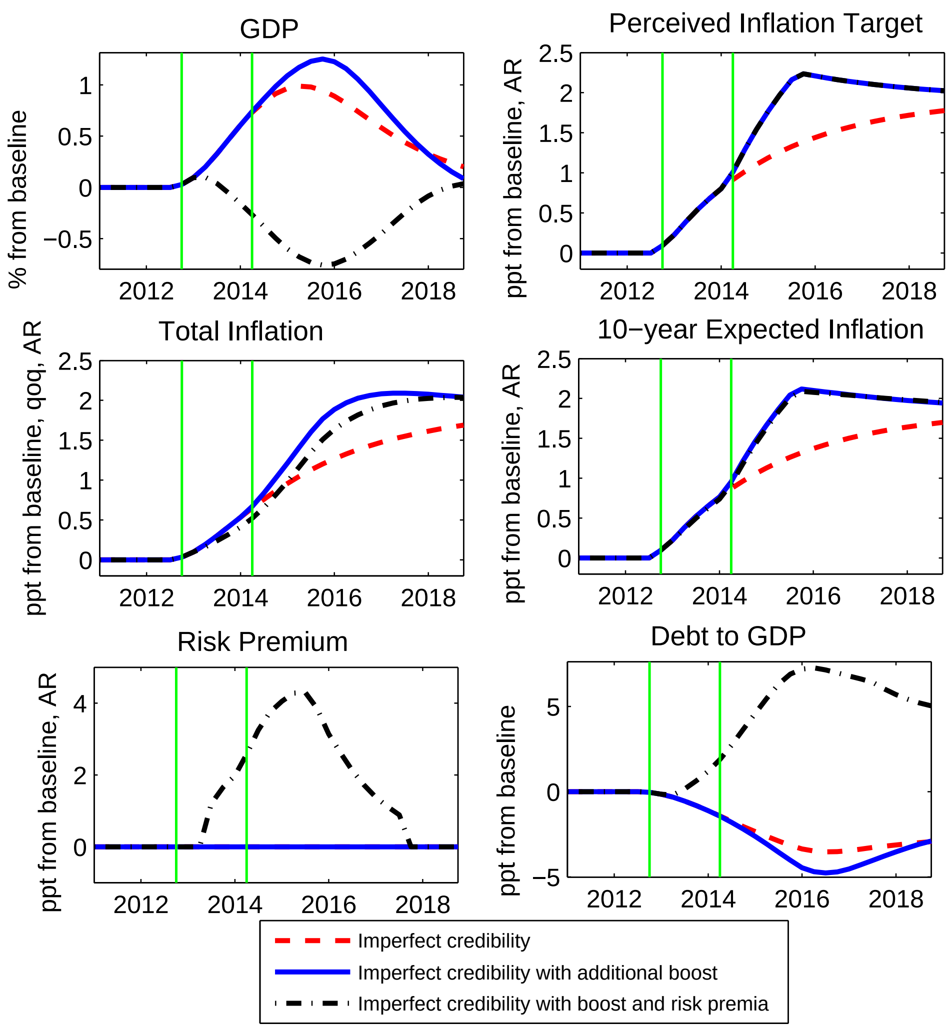
where $\alpha > 0$ is a scaling factor. To the extent that inflation does not accelerate too quickly between one period and the next, $\varepsilon_t = 0$, and the model is unchanged. By contrast, when inflation accelerates quickly, ε_t is positive and the risk premium shock enters the households's first order condition for government debt. Figure A.2 shows the model dynamics when the additional boost to the inflation target leads to a faster pickup in inflation and, in turn, to a rise in risk premia. We set $\lambda = 0.01$ and $\alpha = 20$, so that when quarterly inflation rises at at an annual pace faster than 0.05 percentage point, risk premia increase roughly 400 basis points after eight quarters, a calibration that mimics the rise in sovereign risk spreads of the most vulnerable euro-area countries during the European debt crisis. In this scenario, inflation expectations still meet the 2 percent target by mid-2015, but the rise in risk premia causes output to fall and the debt-to-GDP ratio to rise 6 percentage points above baseline. As a result of the dip in output, inflation rises a bit more slowly.

Figure A.1: Inflation Target Shocks: VAR Evidence for the United States



Note: The panels plot the impulse responses (together with one s.e. bands) to a 2 percentage point inflation target shock (about 3 standard deviations) in the U.S for the period (1970Q1-2013Q4).

Figure A.2: NK Model. Change in Inflation Target: Imperfect Credibility and Risk Premia



Note: The lines plot the impulse response to a 2 percentage point inflation target shock. The shock takes place over three periods (2012Q4-2013Q2) against a baseline where the policy rate is expected to be at zero until 2016Q4. The dashed lines plot the responses when the inflation target is imperfectly observed. The solid lines plot the responses when the target is imperfectly observed, and the central bank announces a temporary increase in the inflation target from 2 to 3 percent between 2014Q2 and 2015Q4. The dash-dotted lines plot the responses when the target is imperfectly observed, the central bank announces a temporary increase in the inflation target from 2 to 3 percent between 2014Q2 and 2015Q4, and risk premia reacts endogenously when inflation increases more than 0.05 percentage point between one quarter and the next. The first vertical green line identifies the start of Abenomics (2012Q4) and the second one corresponds to today (2014Q2).