Rethinking the Power of Forward Guidance: Lessons from Japan

Keynote Speech by Mark Gertler

In the spring of 2013 the Bank of Japan introduced a state-of-the-art monetary policy which included among other things inflation targeting and aggressive use of forward guidance. In contrast to the predictions of conventional macroeconomic theory, these policies have had only very limited success in reflating the economy. I argue that the disconnect between the Japanese experience and existing theory can be traced to the forward guidance puzzle (FGP). As recent literature suggests, the essence of the FGP is that existing models predict implausibly strong effects of expected future interest rate changes on the economy, with the strength of the effect increasing with the expected horizon of the interest rate change. Accordingly, in this lecture I sketch a model meant to capture the challenge of reflation in Japan. As in recent literature I attempt to mute the power of forward guidance by stepping outside of rational expectations. In particular, I introduce a hybrid adaptive/rational expectations belief mechanism. Most relevant to the Japanese experience is that individuals have adaptive expectations about trend inflation, which is consistent with the evidence. As Kuroda (2016) emphasizes, for an economy without a history of inflation being anchored by a target, individuals need direct evidence that the central bank is capable of moving inflation to target.

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I. Introduction

Recent events in the global economy have forced a reevaluation of much of what we know in macroeconomics. Chief among the challenges is accounting for the sustained low inflation and economic weakness in Japan. It is no longer possible to blame the stagnation in Japan on mismanagement of monetary policy. Since the spring of 2013, through the introduction of Quantitative and Qualitative Monetary Easing (QQE), the Bank of Japan has implemented what many view as a state-of-the-art policy program.

Sustained low inflation and economic weakness has been of course a recent global phenomenon. The 2008/9 financial crisis plunged the advanced economies of the world into a liquidity trap. The central banks of these economies, further, have been largely unable to reflate their way out. The general problem, though, has been more severe for Japan. It has lasted much longer, beginning with the financial crisis of the late 1980s. Further, unlike countries such as the U.S., inflation expectations have not been tightly anchored by an inflation target.

From a scientific perspective, it is not easy to explain the difficulties that central banks have had moving their respective economies out of a liquidity trap. The standard models predict that central banks can effectively stimulate an economy in a liquidity trap by managing expectations of future policy. Of course, the central bank's promises about future policy must be seen as credible. If not, "forward guidance" will not be effective. However, I will argue it is unlikely that imperfect credibility alone can account for the slow recovery from a liquidity trap. It may not even be the most significant factor. Indeed, I illustrate with an example below why the commitment problem may not be particularly severe.

Instead I will argue that an important aspect of the disconnect between existing models and the slow global reflation is related to what is now popularly known as the forward guidance puzzle (FGP). The essence of the FGP is that the existing models predict implausibly strong effects of expected future interest rate changes on the economy. Somewhat perversely, as McKay, Nakamura and Steinsson (2016) and Del Negro, Giannoni and Patterson (2012) emphasize, the strength of the effect increases with the expected horizon of the interest rate change.

It has become clear thanks to a rapidly burgeoning literature that the FGP is tied to the assumption of rational expectations. Accordingly, efforts to address the FGP have involved stepping outside the rational expectations hypothesis as a means to introduce some form of effective myopia. For example, Gabaix (2016) and García-Schmidt and Woodford (2015) take a behavioral approach. Angeletos and Lian (2016) introduce incomplete information along with higher order beliefs. Farhi and Werning (2017) combine a behavioral approach with financial market frictions.

In this lecture I take the opportunity to be speculative by sketching a model meant to capture the challenge of reflation in Japan. My approach is not meant to be a final word, just a road map. As in recent literature I attempt to mute the power of forward guidance by stepping outside of rational expectations.

What I offer is less theoretically elegant than in the literature, but has the virtue of being simple and perhaps easier to connect to data, particularly survey data on expectations. In particular I introduce a hybrid adaptive/rational expectations belief mechanism. Individuals have adaptive expectations about macro aggregates (e.g., output and inflation) which is consistent with the survey evidence (see e.g., Coibion and Gorodnichenko [2012]). At the same time they make rational forecasts of policy in the respect that they understood the policy rule and are receptive to central bank communication.[1] As I will argue, this approach is consistent with the evidence that central bank communication indeed affects market interest rates (e.g., Evans *et al.* [2012]).

Most relevant to the Japanese experience is that individuals have adaptive expectations about trend inflation. Unlike the restrictions in standard models, individuals do not simply accept the central bank's desired inflation target as the relevant measure of trend inflation. As Kuroda (2016) emphasizes, for an economy without a history of inflation being anchored by a target, individuals need direct evidence that the central bank is capable of moving inflation to target. That is they have to see it to believe it. It is not so much that they do not trust the central bank's intentions. Rather they need to be convinced that the central bank can indeed deliver on its promises.

II. Some Evidence on Expectations

To motivate the use of an adaptive mechanism for beliefs about macro aggregates, I first present some evidence on survey forecasts versus actual data. I start with U.S. data. Following Coibion and Gorodnichenko (2012), I compare the median forecast from the Survey of Professional Forecasters (SPF) to the realized value of a variable.

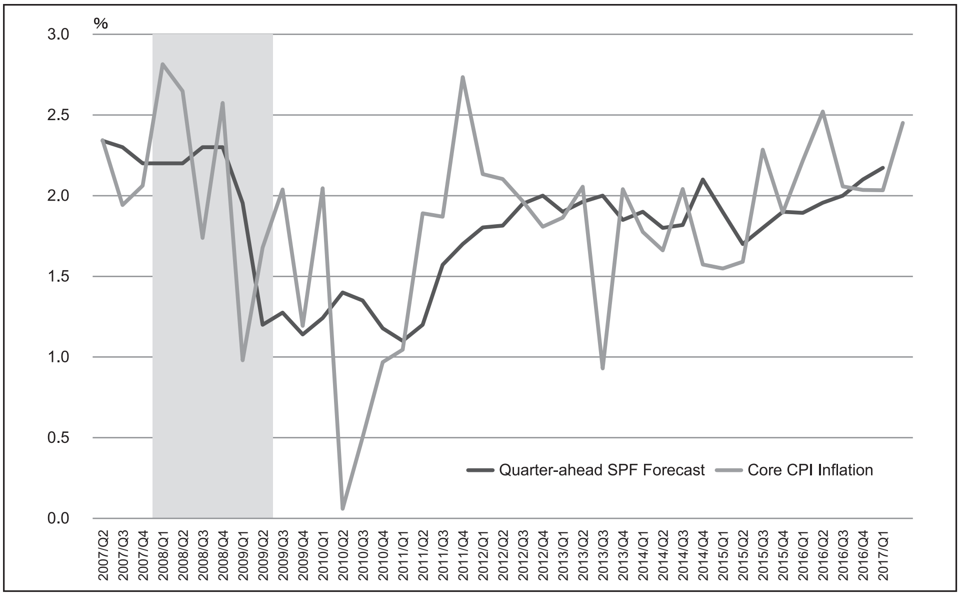
Figure 1 plots the median quarterly SPF forecast of core CPI inflation versus the realized value over the sample 2007Q2 to 2017Q1. There are three points to note: First, the forecast errors appear highly serially correlated. Second, actual inflation tends to lead the movement of expected inflation. Note for example the drop in inflation during the recession and then the increase in mid 2010, each time with expectations lagging behind. Third, after dipping below two percent for several years following the Great Recession, expectations return to this level for the duration of the sample. The first two points appear consistent with an adaptive mechanism. The third suggests that the two percent inflation target may have had a role in helping anchor expectations.

Figure 2 plots the median SPF forecast of real output growth versus the realized value. As with inflation, the forecast errors appear highly serially correlated, with variation in output growth leading the movement in the forecast. Again the evidence is consistent with an adaptive mechanism.

Next I turn to long horizon inflation expectations. Figure 3 plots the median SPF forecast of headline CPI inflation ten years ahead versus actual CPI inflation over the sample 1979Q4 to 2016Q4. For the early years, the Blue Chip forecast stands in for the SPF forecast. It is useful to divide the sample in half. From 1979Q4 to the late 1990s the ten year inflation forecast drifts steadily downward from roughly eight percent to two percent. Actual inflation tends to lead the long horizon forecast downward suggesting an adaptive mechanism. Beginning in the late 1990s the ten year forecast stays roughly anchored just above two percent. While the Federal Reserve did not introduce

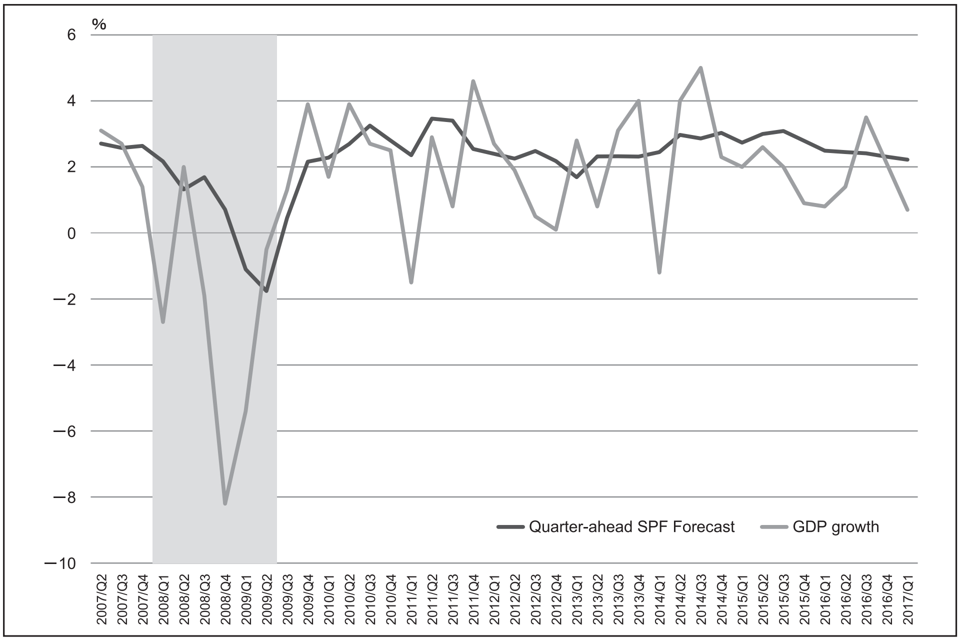
1. In Farhi and Werning (2017) individuals similarly respond "rationally" to forward guidance. In their framework individuals use level k learning to form beliefs about the real sector. There is some similarity between level k learning and adaptive expectations in that near term behavior plays an important role in beliefs about the future.

Figure 1 Core CPI Inflation and Quarter-Ahead SPF Forecast: US Quarterly Data



Sources: The Federal Reserve Bank of Philadelphia; U.S. Bureau of Labor Statistics.

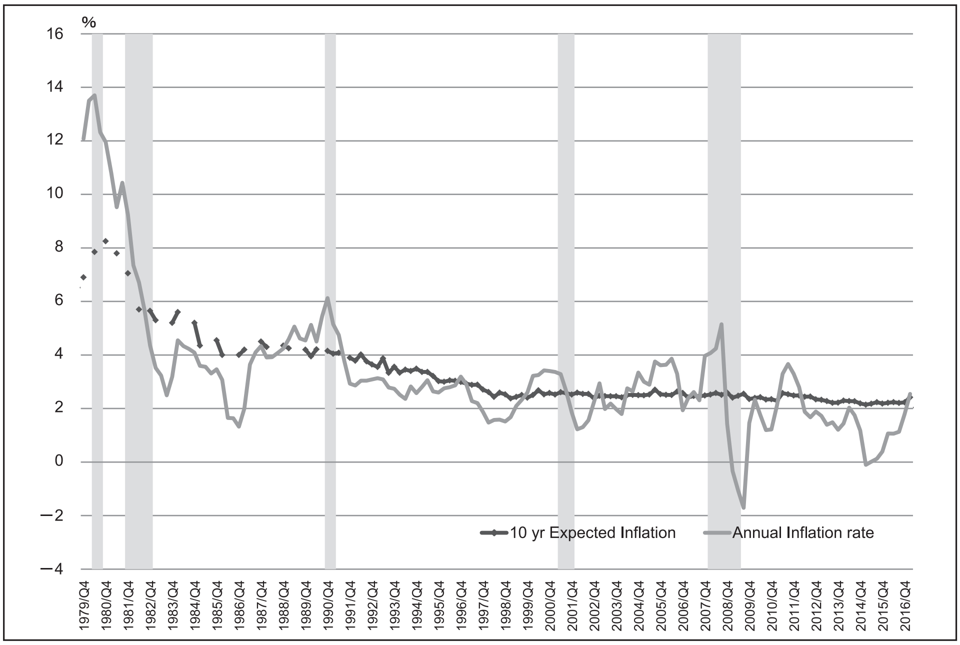
Figure 2 Real GDP Growth and Quarter-Ahead SPF Forecast: US Quarterly Data



Sources: The Federal Reserve Bank of Philadelphia; U.S. Bureau of Labor Statistics.

a formal inflation target until after the Great Recession, it arguably implemented an implicit target of two percent. At the time members of the FOMC began to define two percent inflation as price stability and this practice continued until the implementation

Figure 3 Annual Headline CPI and Expected Rate for Next 10 Years (SPF+Blue Chip): US Data



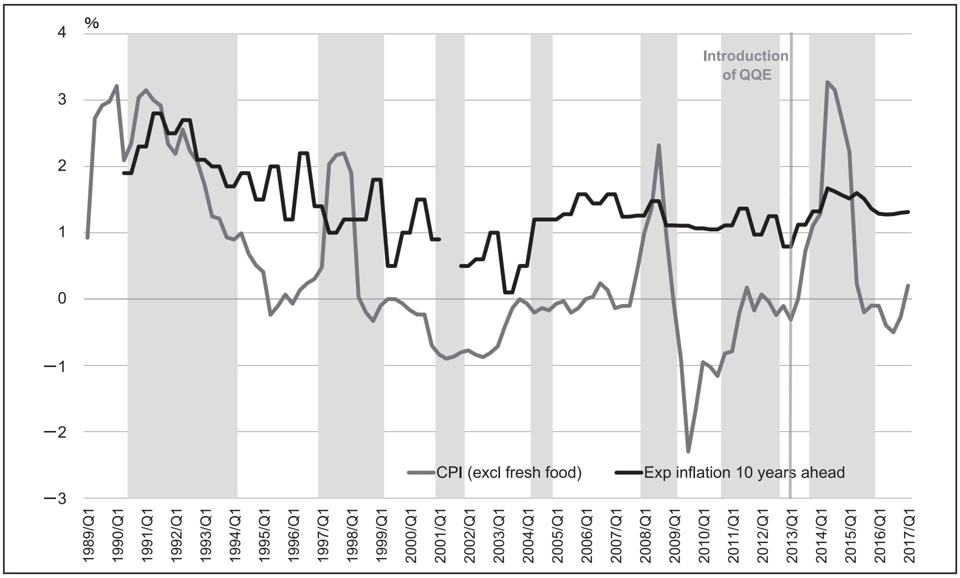
Sources: The Federal Reserve Bank of Philadelphia; Blue Chip Economic Indicators; U.S. Bureau of Economic Analysis.

of a formal target. The long experience with the two percent target (including the period of implicit targeting) undoubtedly helped anchor beliefs in the face of volatile CPI inflation during and after the Great Recession.

Finally, I turn to Japanese data. Figure 4 plots survey expectations of CPI inflation six to ten years out against actual inflation excluding fresh food over the sample 1989Q1 to 2017Q1. Early in the sample, long horizon inflation expectations are roughly three percent. As the Japanese economy experiences a sequence of recessions, inflation steadily drops, turning to deflation at the turn of the century. Long horizon expectations follow behind, suggesting an adaptive mechanism, similar to what occurred in the early part of the U.S. sample (see Figure 3).

Behavior in the latter part of the sample, however, is different from the U.S. While in the U.S. long horizon inflation expectations were roughly at the two percent target, they hovered at one percent on the eve of the ascension of the Abe government to power in early 2013. At this point the stimulus beginning in 2013Q2 from the introduction by the Bank of Japan of QQE pushed inflation up, leading to a slow upward drift of expected inflation. Though the BOJ introduced a two percent target, expectations did not jump immediately to this level. Instead, inflation expectations slowly followed actual inflation upward. Unfortunately, a recession and weakening of commodity prices reduced inflation sharply, inducing a downward drift in inflation, despite the aggressive BOJ policies. Without a history of anchored expectations, the inflation target did not seem to curtail the downward movement in expected inflation.

Figure 4 Inflation and Expected Rate for Next 10 Years: Japanese Data



Sources: Consensus Economics Inc., *Consensus Forecasts*; Ministry of Internal Affairs and Communications of Japan.

III. The Forward Guidance Puzzle: Inspecting the Mechanism

In this section I review the simple New Keynesian model with rational expectations, which serves as the basis for the macroeconomic models used for forecasting and policy evaluation at central banks. I illustrate the power of forward guidance within this framework. I then do several policy experiments to illustrate how the strength of forward guidance suggests escaping a liquidity trap may not be so difficult. This sets the stage for the next section where I dampen the power of forward guidance by introducing a form of hybrid adaptive/rational expectations.

A. New Keynesian Model with Trend Inflation

Consider the canonical New Keynesian model with consumption goods only. The one variation is that I allow for trend inflation, which individuals perceive as obeying a random walk. To keep the algebra as simple as possible, I assume that prices are indexed to trend inflation. Finally, the source of exogenous variation is a demand disturbance in the form of a shock to the household discount factor β_t.

Let y_t be the log of the output gap; i_t the net nominal interest rate; r_t^* the natural (flexible price equilibrium) rate of interest, π_t the rate of inflation from $t-1$ to t and $\overline{\pi}_t$ trend inflation. As is standard, we can then express the model in terms of three equations in three unknowns: y_t, π_t and i_t (see e.g., Clarida, Galí and Gertler [1999], Galí [2015]):

IS curve

$$y_t = E_t y_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_t^*)\,. \tag{1}$$

Phillips curve

$$\pi_t = \lambda y_t + \beta E_t \pi_{t+1} + (1 - \beta)\overline{\pi}_t \,. \tag{2}$$

Policy rule

$$i_t = \max\{r_t^* + \overline{\pi}_t + \phi_\pi(\pi_t - \overline{\pi}_t) + \phi_y y_t, 0\}\,, \tag{3}$$

with $\phi_\pi > 1$; $\phi_y > 0$.

Equation (1) relates the current output gap positively to expected future output gap and inversely to the gap between the real rate of interest $i_t - E_t\pi_{t+1}$ and the natural rate r_t^*. The parameter σ is the household's intertemporal elasticity of substitution. In this simple model $r_t^* = -\log\beta_t$.

Equation (2) relates inflation to the output gap plus a trend term equal to a convex combination of expected inflation next period and trend inflation. The parameter β is the steady state household discount factor. The slope of the Phillips curve λ depends inversely on the degree of price rigidity (measured by the probability a firm does not change price in a period) as well as the elasticity of marginal cost with respect to output.

Finally equation (3) is a simple Taylor rule that has the nominal rate equal to an intercept plus adjustment for deviations of inflation and the output gap from their respective targets. The intercept is the sum of the natural rate and trend inflation. Since the central bank controls trend inflation, the latter must correspond to its inflation target. In addition we impose a zero lower bound constraint. (Later I briefly discuss negative rates.)

B. Rational Expectations and the Power of Forward Guidance

To see the power of forward guidance, we solve the model under rational expectations:

$$y_t = E_t \sum_{j=0}^{\infty} -\sigma(i_{t+j} - \pi_{t+1+j} - r_{t+j}^*)\,. \tag{4}$$

$$\pi_t = E_t \sum_{j=0}^{\infty} \beta^j \lambda y_{t+j} + \overline{\pi}_t \,. \tag{5}$$

Output gap depends inversely on the sum of current and expected future interest gaps while inflation depends on a discounted sum of expected output gaps plus an additive term equal to trend inflation.

We can now see how the effect of $E_t i_{t+j}$ on y_t is increasing in j. First note that the direct effect of $E_t i_{t+j}$ on y_t (from equation (4)) is the same for all j. In other words, there is no discounting of interest rate changes expected to come in the future. As pointed out by Angeletos and Lian (2016) and others, the absence of discounting reflects general equilibrium effects in conjunction with rational expectations. In partial equilibrium, individuals discount the effects of future interest rate changes. Under rational expectations they take into account the effect of the future interest rate change on future aggregate activity and in turn on their future earnings. In this simple model, taking into account the general equilibrium effect exactly undoes the discounting of future interest rate changes.

In addition to the direct effect of $E_t i_{t+j}$ on y_t that is independent of j, there is an indirect effect due to the impact on expected inflation that works to magnify the overall impact. In particular, the direct effect of an increase in $E_t i_{t+j}$ is to reduce y_t. The indirect effect then works as follows. The increase in $E_t i_{t+j}$ reduces $E_t y_{t+k}$ from $k = 1$ to j. This in turn has the effect of reducing the path of inflation over this interval, thus raising the path of real rates. The magnified increase in the path of the real rate amplifies the reduction in y_t. Since this indirect effect is clearly increasing in the horizon j, so too is the overall impact of an increase in $E_t i_{t+j}$ on y_t.

It is also worth emphasizing that there is a significant effect of the inflation target on the path of inflation. Under rational expectations, a (credible) increase in the inflation target leads to an immediate one-for-one increase in inflation.

It is now straightforward to illustrate how the power of forward guidance facilitates managing a liquidity trap. When the sum of the natural rate and trend inflation is negative, i.e., $r_t^* + \overline{\pi}_t < 0$, the zero lower bound on i_t binds. Now suppose that there is a negative demand shock (increase in β_t) that leads to $r_{t+j}^* + \overline{\pi}_{t+j} < 0$ from $j = 0$ to $k - 1$ and ≥ 0 after. Given that the central bank reduces i_t to zero over the period where the zero lower bound is binding, we can express the IS curve as:

$$y_t = E_t \sum_{j=0}^{k-1} \sigma(\pi_{t+1+j} + r_{t+j}^*) + E_t \sum_{j=k}^{\infty} -\sigma(i_{t+j} - \pi_{t+1+j} - r_{t+j}^*) \,. \tag{6}$$

Equation (5) continues to characterize inflation.

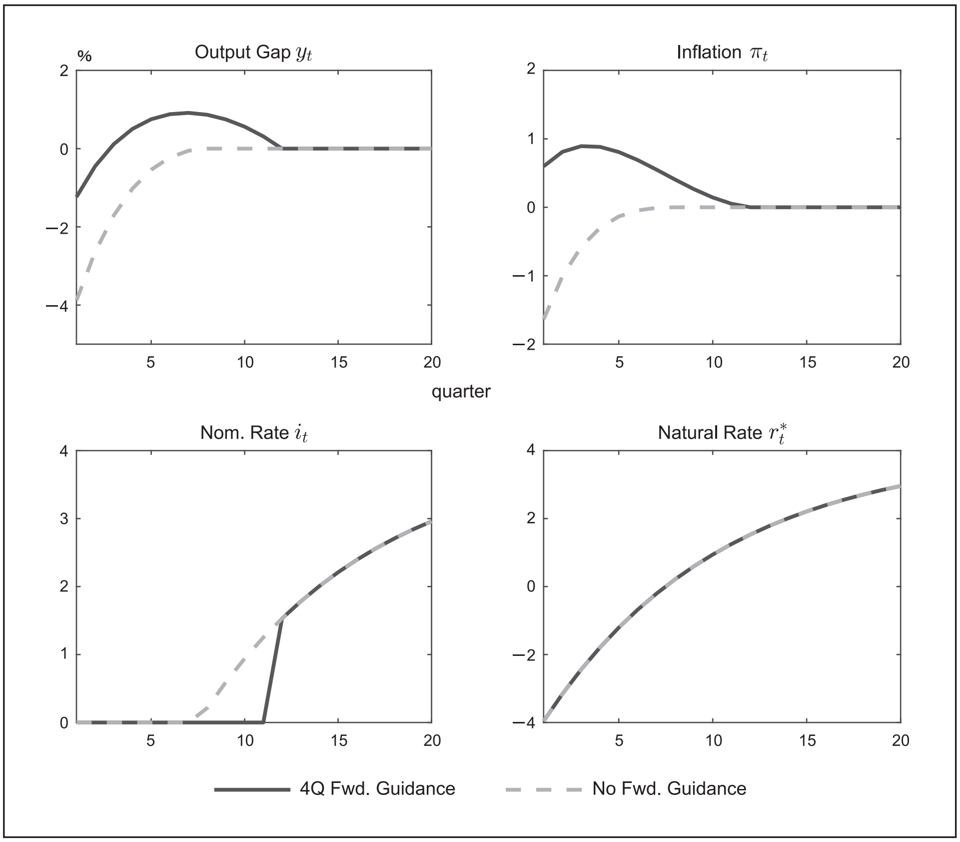
Even with a binding zero lower bound, the model suggests two immediate ways to stimulate the economy in a liquidity trap by managing expectations. First, keep the nominal rate "lower for longer." Commit to keep nominal rates sufficiently low so that the interest rate gap is negative for a period after the economy emerges from the liquidity trap. Given the power of forward guidance, the model suggests that this tool should be effective. Of course it requires that the central bank can commit to pursuing an inflationary policy for a period after the economy is free of the liquidity trap. However, as I demonstrate shortly, the commitment problem may not be especially challenging since only modest levels of inflation overshooting may be required.

The second tool is to raise the inflation target. The simple model suggests that an increase in the target should have an immediate effect on inflation and should thus stimulate the economy by reducing real rates. One might debate whether raising the target above two percent for a country like the U.S. might be credible. However, for Japan, going to a two percent target should not impose any kind of credibility problem.

C. Numerical Illustration

To illustrate the effectiveness of forward guidance under rational expectations, we consider several numerical experiments. To perform the experiments, we use the following parameter values: We set the intertemporal elasticity of substitution σ equal to unity (i.e., log utility) and the quarterly steady state discount factor β equal to 0.99. We fix the slope λ on the output gap in the Phillips curve equal to 0.04 which is within the

Figure 5 Forward Guidance under Rational Expectations



range of estimates in the literature. We set the feedback coefficients in the policy rule ϕ_π and ϕ_y equal to 1.5 and 0.5, respectively. Finally, we assume that steady state trend inflation initially is zero.

We then suppose that the model economy is subject to a demand shock that puts it into a liquidity trap. Suppose, outside the steady state the log of discount factor obeys a first order autoregressive process, with an autoregressive coefficient equal to 0.9. We then consider a negative shock that pushes the natural rate of interest below zero for roughly two years. (Again, the natural rate of interest in this simple model equals minus the log of the discount factor.) Since trend inflation is zero, the economy is in a liquidity trap with a binding zero lower bound on the nominal interest rate over this period.

We now consider three policy responses to the liquidity trap. The first is to do nothing: wait until the economy is out of the liquidity trap and then have policy revert to the Taylor rule. The second two involve management of expectations in an attempt to stimulate the economy while it is still in the liquidity trap. One is to keep rates "lower for longer" by waiting to raise rates until four quarters after the economy is out of the liquidity trap. The other is to raise the inflation target.

Figure 5 analyzes the case where the central bank responds to the liquidity trap by keeping rates lower for longer. As a benchmark, the dashed line in each panel reports the case where the central bank does nothing. In this case the economy experiences a large recession: Output gap falls four percentage points while inflation drops one and a half percentage points. The lower bound on the nominal rate prevents the central bank from stimulating the economy in the absence of managing expectations of future policy.

The solid line reflects the case where the central bank promises to keep the nominal rate at zero for four quarters after the liquidity trap. Due to the promise of lower rates in the future, the recession becomes mild and brief as the output gap becomes positive after several quarters. Inflation no longer falls: It now increases modestly.

It is true that a potential commitment problem emerges. After the economy leaves the liquidity trap (i.e., when the natural rate turns positive after quarter seven) inflation overshoots its target, a consequence of the central bank having to carry out the stimulus it promised earlier. However, the degree of overshooting is relatively modest. Once out of the liquidity trap inflation is less than a half a percent above target for less than a year. This degree of overshooting of the inflation target is well within the norm, for example, of what the Federal Reserve has done in the past twenty years. There is thus reason to believe that a central bank pursuing this kind of policy is likely to be seen as credible by the private sector.

Figure 6 portrays the impact of the central bank raising the inflation target one hundred basis points. Under rational expectations, individuals' expectations of trend inflation immediately increase by the same amount. In turn, holding constant the output gap, inflation increases one hundred basis points. The net effect is a reduction in real interest rates which stimulates the economy. As the solid line shows, relative to the case where the central bank is passive, the stimulus provided from raising the inflation target increases both output gap and inflation. Note that inflation moves quickly to the new target.

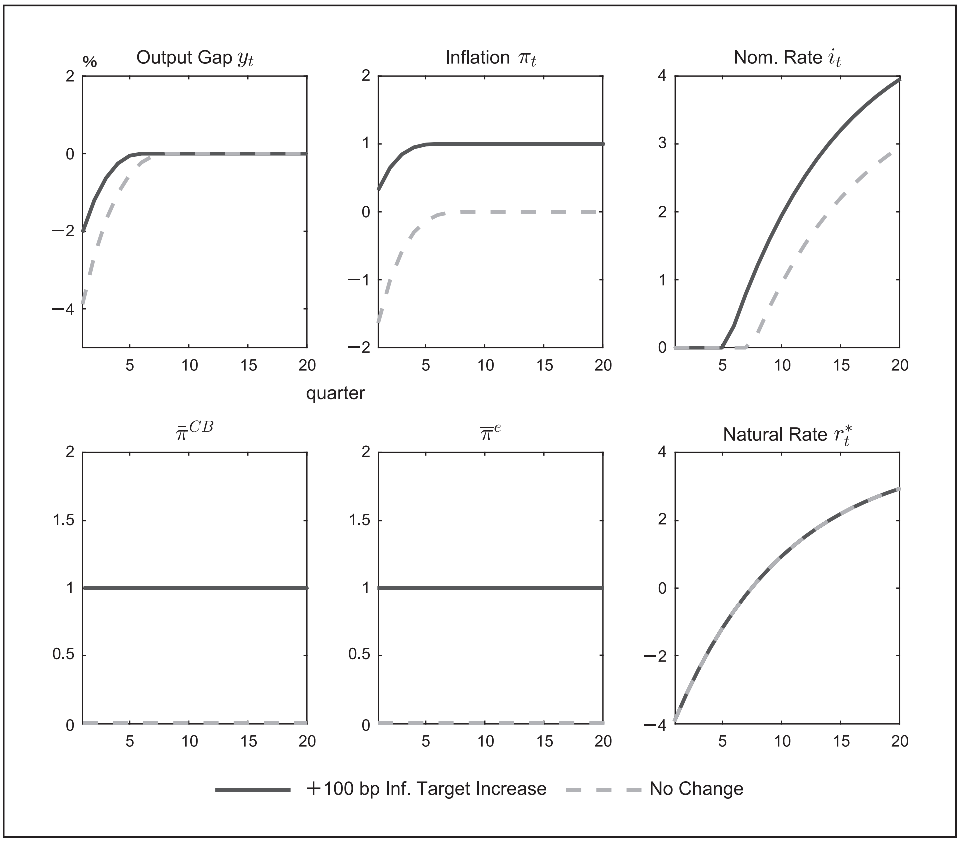
Overall, under rational expectations, forward guidance, i.e., managing expectations of the future path of policy, provides an effective means of stimulating the economy, and implausibly so as many would argue.

IV. A Hybrid Adaptive / Rational Expectations Alternative

In order to dampen the power of forward guidance, I next consider an alternative belief mechanism. The basic idea is as follows. Individuals make rational partial equilibrium decisions, but they're uncertain about how the partial equilibrium feeds into the general equilibrium. In the context of the simple New Keynesian model with consumption goods only, individuals make optimal consumption/saving decisions given their respective beliefs about discounted earnings. While individuals understand how their earnings may be correlated with aggregate output, they are unable to calculate the general equilibrium determination of its expected path. This leads them to use a mixture of adaptive and rational beliefs.

The adaptive part works as follows. Individuals use an adaptive mechanism for beliefs about the future output gap and trend inflation. Given they understand how

Figure 6 +100 bp Inflation Target Increase under Rational Expectations



their own earnings are correlated with the output gap they can use this forecast to project their respective future income. We also allow them to understand the partial equilibrium relation for inflation, i.e., the New Keynesian Phillips curve (equation (2)). Given their forecasts of the output gap and trend inflation, they can then compute a forecast of inflation as I describe below.

The rational part then works as follows. Through experience, individuals understand the central bank policy rule given by equation (3). (Again, they are good at partial equilibrium but not general equilibrium). They also view as credible central bank guidance about the policy instrument path. In this respect, the calculation about the path of the policy instrument is rational. One caveat: while they understand the Taylor rule, they use the adaptive mechanism to form beliefs about the deviations of inflation and the output gap from target. At the same time, they accept central bank guidance about deviations from the traditional rule. It's just they just can't make the calculation of the general equilibrium effect of the policy on the economy.

A. The Model with Hybrid Beliefs

Accordingly, suppose the private sector forecast of the output gap is given by the following adaptive mechanism:

$$\widetilde{E}_t y_{t+1} = \gamma(y_t - \widetilde{E}_{t-1} y_t) + \rho \widetilde{E}_{t-1} y_t \,, \tag{7}$$

where $\widetilde{E}_t$ denotes expectations under our hybrid mechanism. Under beliefs given by equation (7), the updated forecast depends positively on the forecast error $(y_t - \widetilde{E}_{t-1} y_t)$ and the lagged forecast $\widetilde{E}_{t-1} y_t$. The lagged forecast is weighted by $\rho < 1$ to take into account that the output gap is stationary and that individuals recognize this. In the end, the output gap forecast depends on a geometrically distributed lag of current and past values, where the weights sum to a number between zero and unity.

In turn, beliefs about trend inflation are given by the following adaptive mechanism:

$$\widetilde{E}_t \overline{\pi}_t = \delta(\pi_t - \widetilde{E}_{t-1} \overline{\pi}_{t-1}) + \widetilde{E}_{t-1} \overline{\pi}_{t-1} \,. \tag{8}$$

Individuals update their forecast based on the forecast error. They treat trend inflation as non-stationary: Accordingly the weight on the lagged forecast is unity. As a result, the forecast of trend inflation is a geometrically distributed lag of past inflation where the weights sum to unity. Given the forecasts of the output gap and trend inflation and given $\widetilde{E}_t y_{t+1+i} = \rho^i \widetilde{E}_t y_{t+1}$, it is then possible to combine with the Phillips curve (2) to construct a forecast of inflation, as follows:

$$\widetilde{E}_t \pi_{t+1} = \frac{\lambda}{1 - \beta\rho} \widetilde{E}_t y_{t+1} + \widetilde{E}_t \overline{\pi}_t \,. \tag{9}$$

Let $\overline{\pi}_t^{cb}$ be the central bank's inflation target and f_{t+j} be the projected deviation of the interest rate from the policy rule due to forward guidance. Then the forecast of the interest rate is given as follows:

$$\widetilde{E}_t i_{t+j} = \max\{\widetilde{E}_t[r^*_{t+j} + \overline{\pi}_t^{cb} + \phi_\pi(\pi_{t+j} - \overline{\pi}_t^{cb}) + \phi_y y_{t+j} - f_{t+j}],\ 0\} \,. \tag{10}$$

We assume individuals know the form of the policy rule. They use the adaptive forecasts of π_t and y_t to construct measures of deviations of inflation and output gap from target. But at the same time, they view as credible central bank pronouncements about the inflation target as well as central bank guidance about the future path of interest rates. Put differently, in computing the expected path of the interest rate, they accept the central bank's pronouncements about $\overline{\pi}_t^{cb}$ and f_{t+j}. In this regard, central bank communication about the path of future policy (through both $\overline{\pi}_t^{cb}$ and f_{t+j}) will indeed affect the expected path of rates.

Under "hybrid" expectations, the complete model is then given by the following three equations:

IS curve

$$y_t = \chi \widetilde{E}_t y_{t+1} + \widetilde{E}_t \sum_{j=0}^{\infty} \beta^j [-\sigma(i_{t+j} - \pi_{t+1+j} - r^*_{t+j})] \,. \tag{11}$$

Phillips curve

$$\pi_t = \lambda(y_t + \frac{\beta}{1-\beta\rho}\widetilde{E}_t y_{t+1}) + \widetilde{E}_t \overline{\pi}_t \,. \tag{12}$$

Policy rule

$$i_t = \max\{r_t^* + \overline{\pi}_t^{cb} + \phi_\pi(\pi_t - \overline{\pi}_t^{cb}) + \phi_y y_t - f_t, 0\}\,, \tag{13}$$

with $\chi = \frac{1-\beta}{1-\rho\beta} < 1$ and where the forecasts of $y_t, \pi_t, \overline{\pi}_t$ and i_t are given by equations (7), (8), (9) and (10), respectively.

Relative to the case of rational expectations, the power of forward guidance is muted in the model with hybrid beliefs. Note first that in the aggregate demand relation given by equation (11), the effect of future interest rates is discounted by β^j, unlike what occurs under rational expectations. Second, given that forecasts of inflation are adaptive, the movement in expected inflation is muted, which dampens the effect of an expected future nominal rate change on the path of real rates. In contrast to the case of rational expectations, there is no large multiplier effect on real rates arising from movement in expected inflation.

B. Numerical Experiments with Hybrid Beliefs

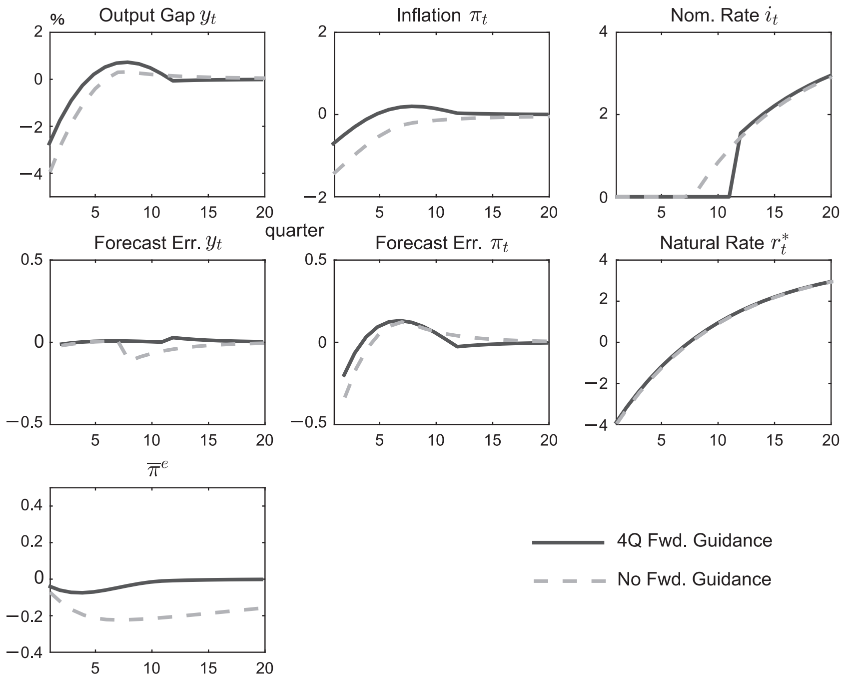
We now repeat the policy experiments we performed with the model under rational expectations. For the adaptive rule for output gap, we suppose that the updating parameter γ is given by 0.125 and the serial correlation parameter ρ is given by 0.95. This calibration suggests that individuals use a geometrically distributed lag of roughly two years of past data to forecast the output gap. We suppose much slower adjustment of beliefs about trend inflation: δ is given by 0.5. In this instance individuals effectively use more than ten years of lagged data.[2]

As earlier, we consider a demand shock that the pushes the economy into a liquidity trap for roughly seven quarters. Also as before, we first consider the effect of the central bank promising to keep the nominal rate at zero for a year after the economy leaves the liquidity trap. Figure 7 illustrates the results. Once again, the dashed line is the case with no forward guidance, while the solid line reflects the case with forward guidance, though this time with hybrid expectations as opposed to rational expectations.

Overall, the policy response has a much weaker effect on output gap and inflation than under rational expectations. In the latter case, the policy virtually eliminated the output gap and pushed inflation modestly above target. Under hybrid expectations the impact is more modest. The policy is stimulative since individuals recognize that the liftoff of nominal rates from zero will be delayed. However, the output gap decline is only about one percent less than the case of no policy response. Similarly, inflation dips before returning to target. The weak response of economic activity to the stimulus, of course, is the product of how the hybrid belief mechanism dampens the power of forward guidance.

2. Though it is beyond the scope of this paper, one way to discipline the learning parameters would be to match the serial correlation in the forecast errors from the survey data.

Figure 7 Forward Guidance under Hybrid Expectations



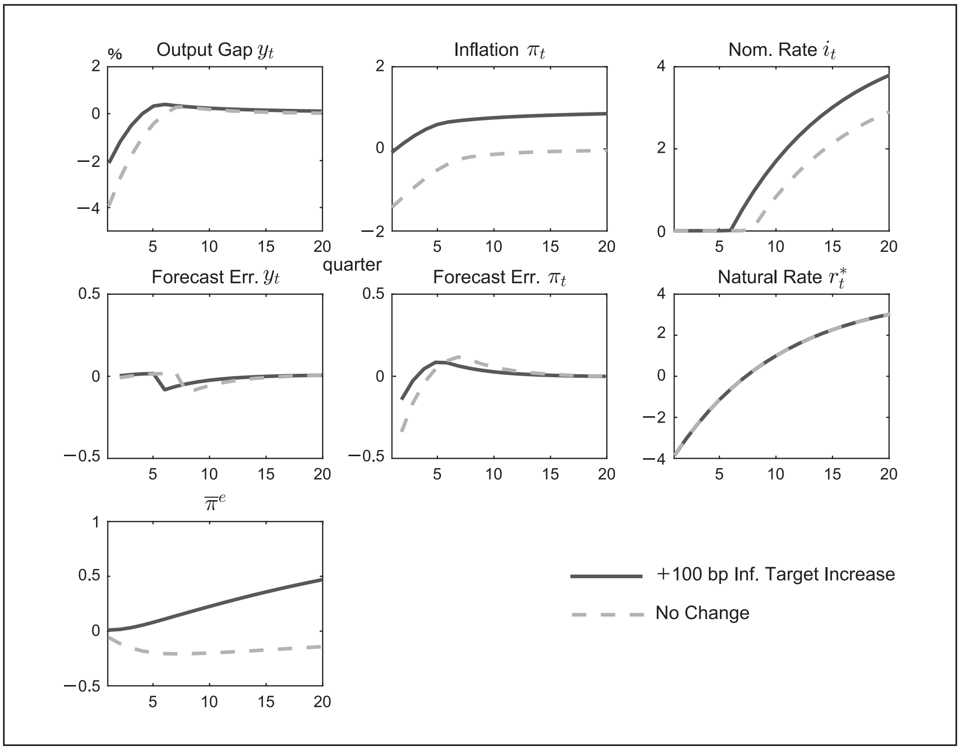
Next we consider raising the inflation target by one hundred basis points. Under rational expectations, there is an immediate jump in beliefs about trend inflation. With adaptive expectations about trend inflation, individuals have to see it to believe it. As Figure 8 illustrates, relative to the case of rational expectations, there is a much slower increase in inflation, mainly due to the slow adjustment of expectations of trend inflation. The policy does provide some stimulus, though. Raising the inflation target implies that everything else equal, the path of future interest rates will be lower (given that the feedback coefficient on inflation, ϕ_π exceeds unity). The reduction in expected future interest rates then stimulates current spending. Thus, even though individuals have adaptive expectations about output gap and inflation, they do respond to central bank efforts to stimulate by managing expectations.

We next explore how transitory factors can affect the central bank's ability to achieve the inflation target. The motive is to understand how the recession and commodity deflation during 2014/15 frustrated the BOJ's effort to reflate the economy. We accordingly modify the model to introduce a cost shock u_t that obeys the following first order process:

$$u_t = \rho_u u_{t-1} + \epsilon_t ,$$

where the error term ϵ_t is i.i.d. with mean zero. The cost shock affects the Phillips

Figure 8 +100 bp Inflation Target Increase under Hybrid Expectations



curve as follows:

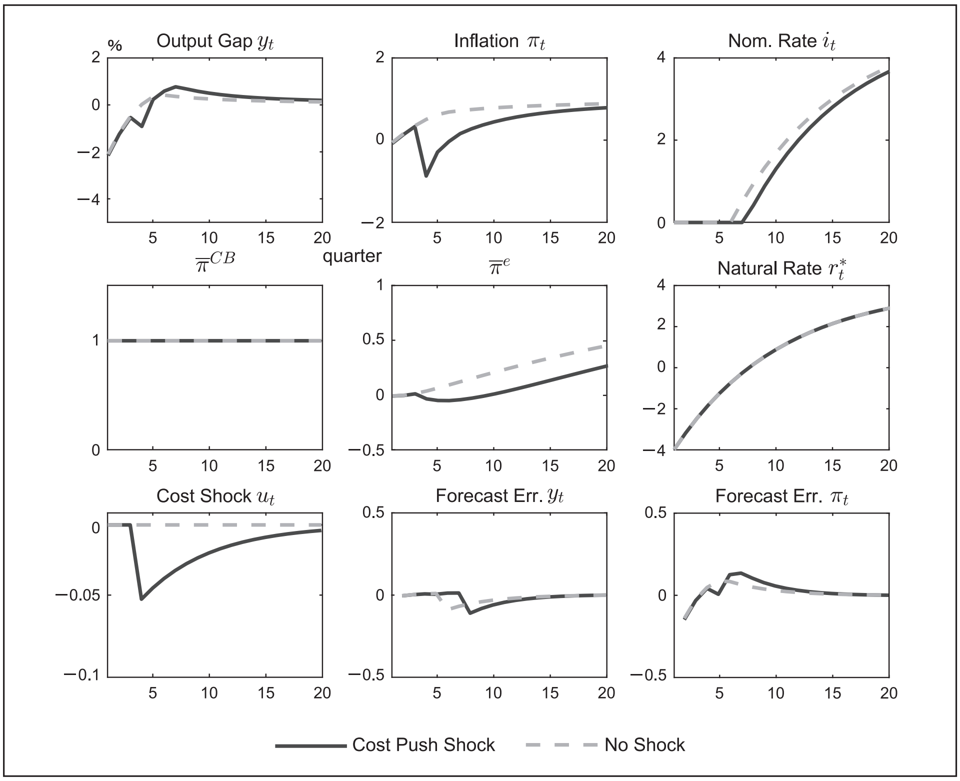
$$\pi_t = \widetilde{E}_t \sum_{j=0}^{\infty} \beta^j [\lambda y_{t+j} + \kappa u_{t+j}] + \widetilde{E}_t \overline{\pi}_t \, . \tag{14}$$

$$\pi_t = \lambda (y_t + \frac{\beta}{1-\beta\rho} \widetilde{E}_t y_{t+1}) + \widetilde{E}_t \overline{\pi}_t + \frac{\kappa}{1-\rho_u} u_t \, . \tag{15}$$

I now repeat the experiment of Figure 8. The economy is hit by a demand shock that moves it into a liquidity trap. The central bank responds by raising the inflation target by one hundred basis points. This time, however, while in the liquidity trap, the economy also experiences a reduction in costs (i.e., a drop in u_t) which reduces inflation. Given adaptive beliefs about trend inflation, the cost shock leads a decline in the long horizon forecast of inflation, similar to what happened in Japan (Figure 9). Interestingly, the shock also induces a decline in output gap: The reduction in inflation expectations raises the real interest rate, reducing demand.

Overall, the model captures how bad luck due to recession and commodity price deflation can frustrate the central bank's efforts to reflate, as occurred recently in Japan. At the same time, good luck could do just the opposite. For example, if the global economy picks up, then commodity prices and inflation may increase, helping economic activity and inflation in Japan move back to target.

Figure 9 +100 bp Inf. Target and Cost Declines under Hybrid Expectations



V. Connection to QQE

I now discuss briefly how the analysis relates to QQE. There were four key aspects to the April 2013 plan. The first was to set an inflation target of 2%. The second was to commit to a sustained rise in the monetary base by expanding asset purchases. The third was to purchase long term bonds. The fourth, which was introduce more recently, was to implement negative interest rates.

I would argue that the first two policies correspond to what I analyzed in the simulations. Raising the inflation target corresponds exactly to one of the policy experiments I considered. Given that increasing the monetary base pushes short rates down, the promise of sustained monetary base expansion, in turn, is in effect a promise to keep short rates low after the economy has recovered from the liquidity trap. In this respect it corresponds to the policy of keeping rates "lower for longer."

The second two policies, long-term bond purchases and negative interest rates, are appealing in light of the muted power of forward guidance. In particular, the analysis suggests that, changes in credit costs today, everything else equal, are going to have a greater effect than projected reductions in costs way into the future. Long-term bond purchases reduce current costs by reducing term premia. Negative interest rates obviously reduce credit costs today directly as well.

Overall, both of the policies make sense in light of the muted power of forward guidance. But it's also the case that there's limits to how much one can use each tool to reduce credit costs. Bond purchase can only push down the term premium so much. Otherwise, private speculators will start issuing long-term bonds and going long in short term assets. The government could also start issuing long-term bonds. There's also a limit to how much one make rates negative because individuals and institutions will go into cash.

VI. Concluding Remarks

As the Japanese experience makes clear, the process of reflation from a liquidity trap can take much longer than most existing macroeconomic models suggest. This can be true even with textbook state-of-the-art monetary policy. This phenomenon is a lot easier to understand once we step outside of pure rational expectations. Accordingly, this paper develops a hybrid adaptive/rational mechanism for formation of beliefs and uses the approach to illustrate the challenges of a central bank in trying to reflate by managing beliefs about future policy. A key lesson from the Japan experience is that absent a history of inflation being anchored by a target, individuals need to see some inflation in order to believe that more is coming.

Creating inflation in turn is certainly going to involve skill on the part of the central bank. But, it is also going to involve luck. Despite the best efforts of a central bank, global factors that moderate inflation may frustrate efforts to reflate. So what is the best course of action? Continue aggressive monetary policy and hope for some luck. Some cooperation from fiscal policy of the kind that Ben Bernanke discussed earlier in the conference may also help (Bernanke [2017]).

APPENDIX: DERIVATION OF THE IS CURVE UNDER HYBRID EXPECTATIONS

The baseline framework is a textbook NK model with consumption goods only. Output is linear in labor. Discount factor shocks are the only source of variation. A representative household chooses consumption/saving and labor supply to maximize expected discount utility. Period utility is separable in consumption and labor supply. Period utility from consumption is logarithmic.

Let c_t be the log deviation of consumption from steady state and v_t be the log deviation of household wealth, including human wealth and asset wealth. Note that since (i) utility is logarithmic, (ii) there are only discount factor shocks and (iii) consumption equals output and output equals labor, the flexible price equilibrium values of both consumption, employment and output are constant. Hence c_t is also the log deviation of consumption from its natural value.

Combining the loglinearized first order conditions from the household consumption/saving problem with the loglinearized budget constraint yields the following relationship for consumption demand:

$$c_t = v_t \,. \tag{16}$$

$$v_t = E_t \sum_{j=0}^{\infty} \{(1-\beta)\beta^j y_{t+j} - \beta^{1+j}(i_{t+j} - E_t \pi_{t+1+j} - r^*_{t+j})\} . \tag{17}$$

In keeping with the permanent income hypothesis, consumption varies proportionately with wealth. Wealth in turn is the expected discounted sum of income, where y_{t+i} is the sum of labor income and profits from monopolistically competitive firms.

As the literature emphasizes, discounting of the future disappears in the rational expectations general equilibrium. To see, express v_t recursively:

$$v_t = (1-\beta) y_t + \beta E_t v_{t+1} - \beta (i_t - E_t \pi_{t+1} - r^*_t) . \tag{18}$$

Given $c_t = y_t$, it follows that $y_t = v_t$ and $E_t y_{t+1} = E_t v_{t+1}$. Accordingly we can write

$$y_t = (1-\beta) y_t + \beta E_t y_{t+1} - \beta (i_t - E_t \pi_{t+1} - r^*_t) . \tag{19}$$

Rearranging then yields the familiar New Keynesian IS curve:

$$y_t = E_t y_{t+1} - (i_t - E_t \pi_{t+1} - r^*_t) . \tag{20}$$

Observe that discounting of the future disappears after the general equilibrium with rational expectations is imposed.

To see how discounting remains under hybrid beliefs, first note that aggregate demand can be expressed as:

$$y_t = \widetilde{E}_t \sum_{j=0}^{\infty} \{(1-\beta)\beta^j y_{t+j} - \beta^{1+j}(i_{t+j} - E_t \pi_{t+1+j} - r^*_{t+j})\} , \tag{21}$$

where $\widetilde{E}_t$ is the expectation operator under hybrid beliefs and has the following properties for forecasts of output gap:

$$\begin{aligned} \widetilde{E}_t y_t &= y_t , \\ \widetilde{E}_t y_{t+1} &= \gamma (y_t - \widetilde{E}_{t-1} y_t) + \rho \widetilde{E}_{t-1} y_t , \\ \widetilde{E}_t y_{t+1+i} &= \rho^i \widetilde{E}_t y_{t+1} . \end{aligned} \tag{22}$$

Combining (21) and (22) then yields

$$y_t = \widetilde{E}_t \sum_{j=0}^{\infty} \{(1-\beta)(\beta\rho)^j y_{t+1} - \beta^j (i_{t+j} - E_t \pi_{t+1+j} - r^*_{t+j})\} , \tag{23}$$

which can be rearranged to obtain the IS curve under hybrid beliefs:

$$y_t = \chi \widetilde{E}_t y_{t+1} + \widetilde{E}_t \sum_{j=0}^{\infty} \beta^j [-\sigma (i_{t+j} - \pi_{t+1+j} - r^*_{t+j})] , \tag{24}$$

with $\chi = \frac{1-\beta}{1-\rho\beta}$. Under the hybrid mechanism, accordingly, discounting remains.

References

Angeletos, George-Marios, and Chen Lian, "Forward Guidance without Common Knowledge," mimeo, 2016.

Bernanke, Ben S., "The Mayekawa Lecture: Some Reflections on Japanese Monetary Policy," *Monetary and Economic Studies*, 35, Institute for Monetary and Economic Studies, Bank of Japan, 2017, pp. 23–38 (this issue).

Clarida, Richard, Jordi Galí, and Mark Gertler, "The Science of Monetary Policy: A New Keynesian Perspective," *Journal of Economic Literature*, 37(4), 1999, pp.1661–1707.

Coibion, Olivier, and Yuriy Gorodnichenko, "What Can Survey Forecasts Tell Us about Information Rigidities?" *Journal of Political Economy*, 120(1), 2012, pp. 116–159.

Del Negro, Marco, Marc Giannoni, and Christina Patterson, "The Forward Guidance Puzzle," Staff Reports, 574, Federal Reserve Bank of New York, 2012.

Evans, Charles L., Jonas D.M. Fisher, Alejandro Justiniano, and Jeffrey R. Campbell, "Macroeconomic Effects of FOMC Forward Guidance," *Brookings Papers on Economic Activity*, Spring, 2012, pp. 1–80.

Farhi, Emmanuel, and Iván Werning, "Monetary Policy, Bounded Rationality, and Incomplete Markets," mimeo, 2017.

Gabaix, Xavier, "A Behavioral New Keynesian Model," NBER Working Paper No. 22954, National Bureau of Economic Research, 2016.

Galí, Jordi, *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and Its Applications,* 2nd Edition, Princeton University Press, 2015.

García-Schmidt, Mariana, and Michael Woodford, "Are Low Interest Rates Deflationary? A Paradox of Perfect-Foresight Analysis," mimeo, 2015.

Kuroda, Haruhiko, "Re-Anchoring Inflation Expectations via 'Quantitative and Qualitative Monetary Easing with a Negative Interest Rate'," remarks at the Economic Policy Symposium held by the Federal Reserve Bank of Kansas City on August 27, 2016.

McKay, Alisdair, Emi Nakamura, and Jón Steinsson, "The Power of Forward Guidance Revisited," *American Economic Review,* 106(10), 2016, pp. 3133–3158.