Deflation Risks Under Alterntive Monetary Policy Rules

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Motivation

Concern About Deflation and hitting the Zero Interest Rate Floor (ZIF) in the G3 economies:

- Forecasts for growth and inflation in the G3 economies have been revised down substantially over the last few months and the recent data suggest that these economies could weaken further without additional monetary and fiscal stimulus.

- Most previous work has been based on arbitrary initial conditions for the economy and has suggested that there are small risks of deflation.

In this paper we....

- Use an estimate model for the G3 economies based on work by Carabenciov and others (2008).

- Construct a conditional baseline forecast and confidence bands that respect the ZIF.

- Consider alternative monetary policies (IT and PLPT with different long-term targets) to study the risks and costs of deflation.

- Preliminary Results: Some major extensions underway (adding fiscal stance, term structure, distinguishing between core and headline, updating the baseline because the data are changing rapidly) and considering the gains from coordination.

What model and why?

The Global Projection Model (GPM) has a number of useful features for this exercise.

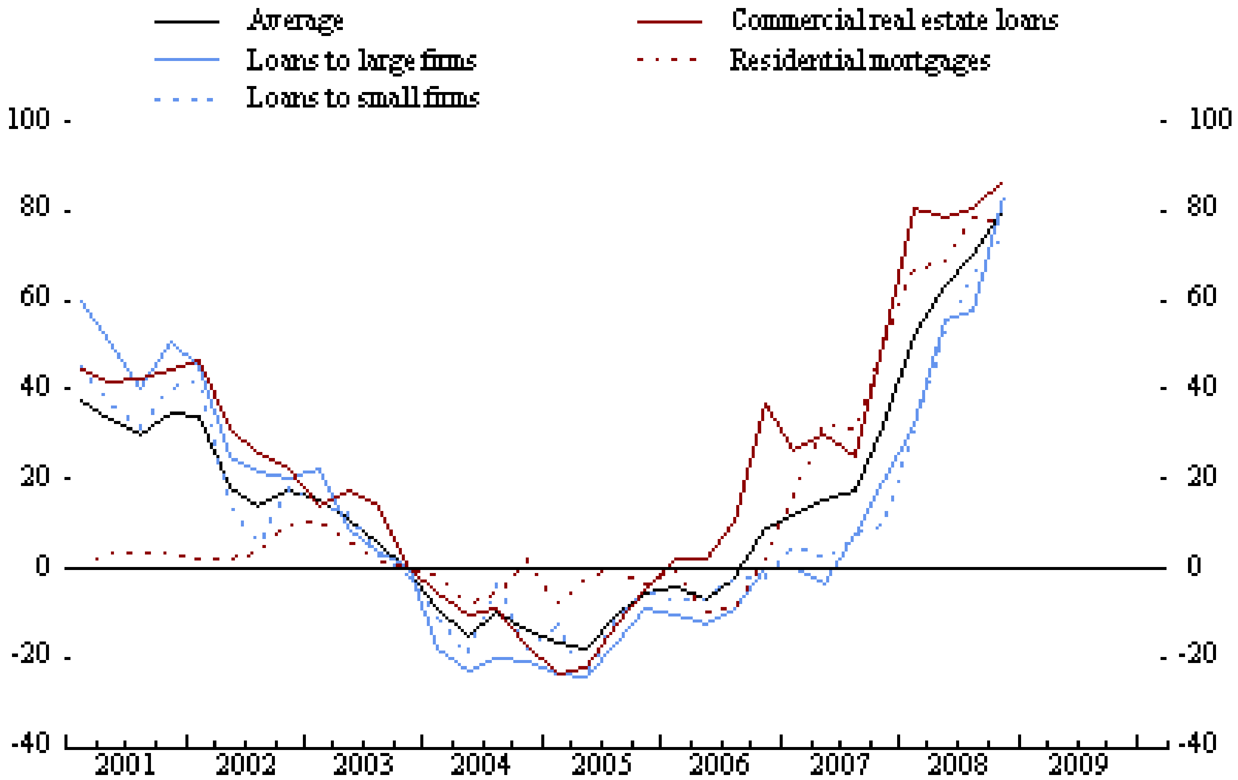
- It takes some restrictions from theory, but does not impose tight restrictions on dynamics that are inconsistent with the data.

- Model parameters and all latent variables are estimated as a system of equations including all stochastic distributions.

- The model includes a measure of Bank Lending Tightening (BLT) for the United States that has done an uncanny job at predicting the U.S. output gap over the last decade. Let's hope this relationship breaks down because it currently portends major weakness in the US economy with significant spillover effects on the rest of the world.

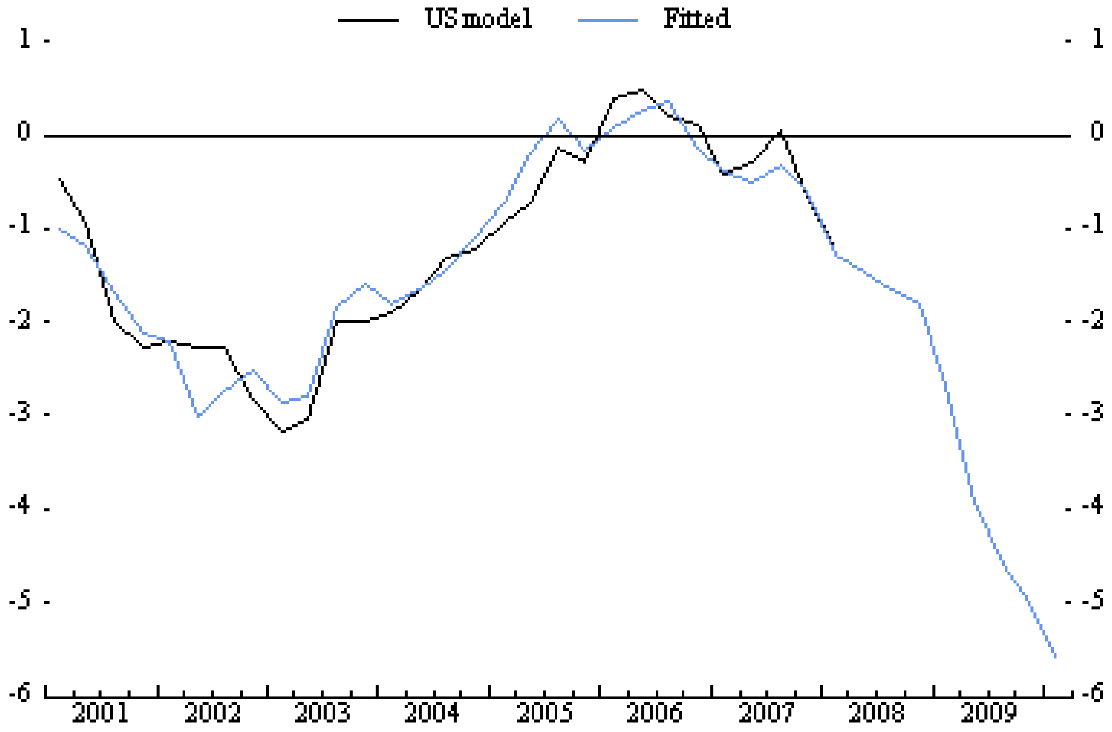
U.S. Bank Lending Tightening

(In percent)



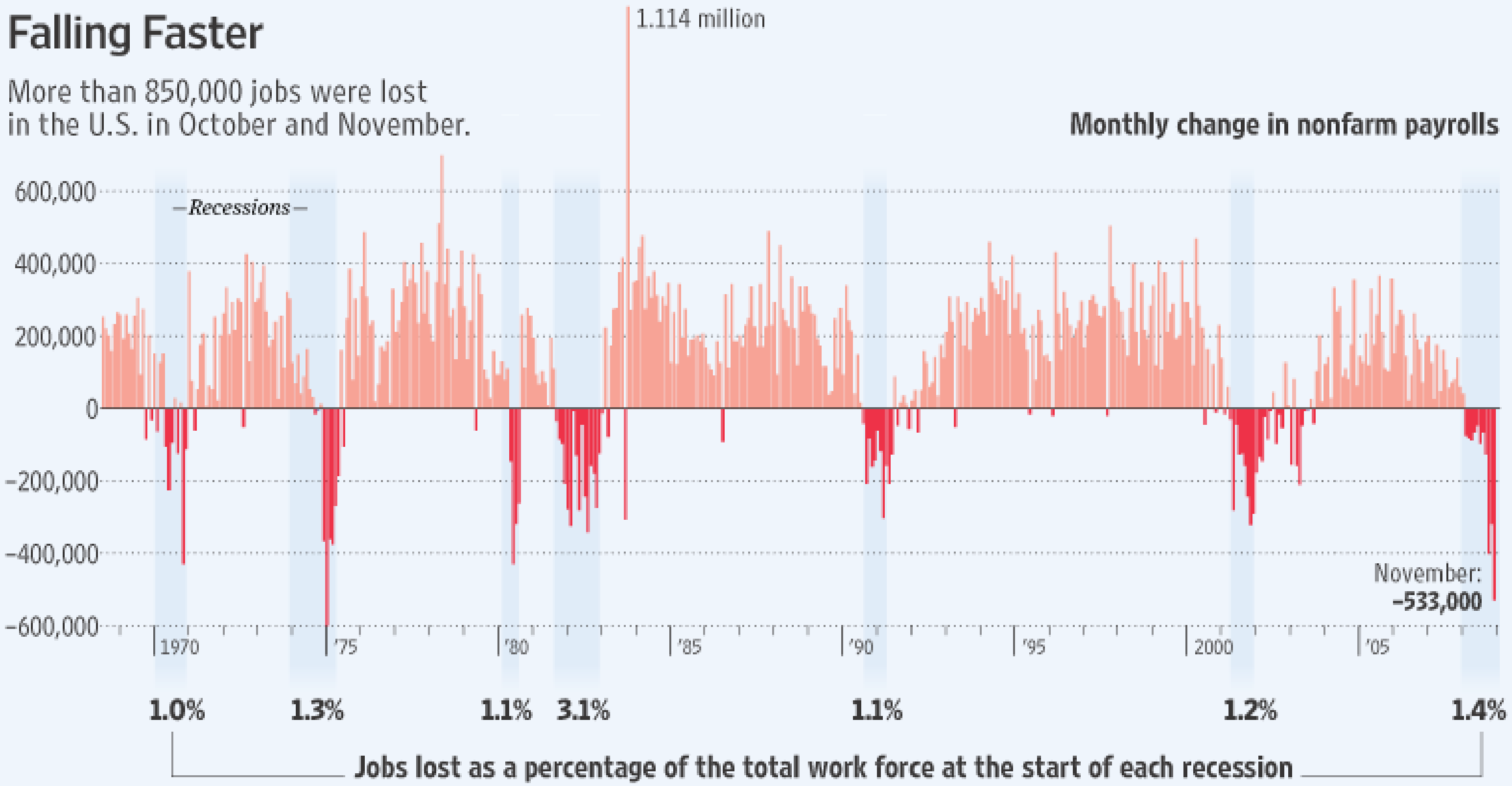
U.S. Output Gaps Based on a U.S. Model

(In percent)



Falling Faster

More than 850,000 jobs were lost
in the U.S. in October and November.



Source: Labor Department (jobs); National Bureau of Economic Research (recessions)

Output Gap Equation

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t+1} - \beta_3 r_{t-1} + \beta_4 \sum_j \omega_{j,4} z_{j,t-1} + \beta_5 \sum_j \omega_{j,5} y_{j,t-1} - \theta \eta_t^{BLT} + \varepsilon_t^y$$

- The output gap (y_t) depends on last quarter's output gap, next quarter's output gap, real exchange rate gaps ($z_{j,t-1}$), output gaps in other countries ($y_{j,t-1}$) and past innovations in Bank Lending tightening ($\theta \eta_t^{BLT}$).

- In the extended version of the model we also allow for state-dependent effects from negative aggregate demand shocks that generate asymmetries in the model's confidence bands. This is consistent with empirical work that suggests confidence effects on aggregate demand become more important in large recessions.

Inflation Equation

$$\pi_t = \lambda_1 * \pi4_{t+4} + (1 - \lambda_1) * \pi4_{t-1} + \lambda_2 * y_{t-1} + \lambda_3 * \Delta z_t + \varepsilon_t^{\pi}$$

- Inflation is a function of inflation expectations ($\pi4_{t+4}$), lagged inflation ($\pi4_{t-1}$), the lagged output gap (y_{t-1}) and the change in the real exchange rate (Δz_t).
- The model includes a convex function for the output gap $\lambda_2 \left(\frac{y_{t-1}}{y_{\max} - y_{t-1}} y_{\max} \right)$, suggesting that excess demand raises inflation by more than what excess supply reduces it. We need this because we are considering model solutions with some fairly large negative output gaps.
- For small variation in the output gap the model is approximately linear ($\lambda_2 * y_{t-1}$), which is what is used for estimation.

Orphanidies Interest Rate Reaction Function

$$\begin{aligned} rs_t^u &= (1-\gamma_1)\overline{rr}_t + \pi 4_{t+3} + \gamma_2(\pi 4_{t+3} - \pi^{tar}) + \gamma_4 y_t \\ &\quad + \gamma_1 rs_{t-1} + \varepsilon_t^{rs} \end{aligned}$$

$$rs_t^c = \max(rs_t^u, 0)$$

Estimated short-run coefficients IT policy rule			
	US	euro area	Japan
Rate Smoothing ($\gamma_{j,1}$)	0.73	0.70	0.80
Expected Inflation (1-$\gamma_{j,1}$+$\gamma_{j,2}$)	0.52	0.68	0.43
Output gap ($\gamma_{j,4}$)	0.06	0.06	0.03

- The unconstrained policy interest rate (rs_t) reaction function is a standard inflation-forecast based rule that depends on the equilibrium real interest rate ($\overline{rr}_t$), expected year-on-year inflation ($\pi 4_{t+3}$), the output gap (y_t) and a lagged inertia term (rs_{t-1}).

Optimized PLPT-Based Reaction Function

$$L = .5\, Var\left(\Delta i\right) + Var\left(\pi 4 - \pi^{*}\right) + Var\left(y\right), \tag{1}$$

$$\begin{aligned} rs_t^u \;=\;& (1-\gamma_1)\overline{rr}_t + \pi 4_{t+3} + \gamma_2(\pi 4_{t+3} - \pi^{tar}) + \gamma_3(p4_{t+8} - p_{t+8}^{tar}) + \gamma_4 y_t \\ & + \gamma_1 rs_{t-1} + \varepsilon_t^{rs} \end{aligned}$$

Optimal short-run coefficients Combined IT-PLPT policy rule			
	US	euro area	Japan
Rate smoothing ($\gamma_{j,1}$)	0.70	0.52	0.93
Expected Inflation (1-$\gamma_{j,1}$+$\gamma_{j,2}$)	0.26	0.29	0.20
PLPT gap ($\gamma_{j,3}$)	0.60	0.38	0.07
Output gap ($\gamma_{j,4}$)	0.50	1.08	0.19

- The optimal parameters have higher weights on the output gap and positive weights on deviations in the expected price level from its target path 8 quarters into the future.

Confidence Bands Simulation

- Since the model is non-linear, we have to simulate many draws of shocks to get estimates of the confidence bands
- Future risks of shocks correspond to the historical estimates
- Naive Monte Carlo simulation breaks because of the high dimensionality of the problem (number of shocks, number of periods and number of state variables)
- We opted for a more structured way of drawing the shocks in order to more evenly sweep the high dimensional space — Latin Cube Sampling
- This sampling technique implies a faster convergence; in other words, less number of simulations is needed to obtain good estimates of the confidence bands

Latin Cube Sampling

- Latin Cube sampling algorithm draws points from unit hypercube $\langle 0,1\rangle^D$, where D is a dimension

- In our case, $D = 12 \times 36 = 432$, where 12 corresponds to periods, and 36 to a number of shocks

- We simulate $K = 1200$ simulations, so we obtain by the Latin Cube algorithm K draws each having $D = 432$ coordinates.

- Each series of 432 numbers is split to 12 parts, each part corresponds to a draw of shocks in one period

- However, these draws are from uniform distribution, so we need to transform each 36-tuple to the Gaussian distribution and then multiply with a Cholesky factor of the variance-covariance matrix

Latin Cube Sampling Example

To build an intuition of how Latin Cube algorithm works, we provide an example of generating $K = 6$ draws from the unit square $\langle 0, 1 \rangle^2$, i.e. $D = 2$.

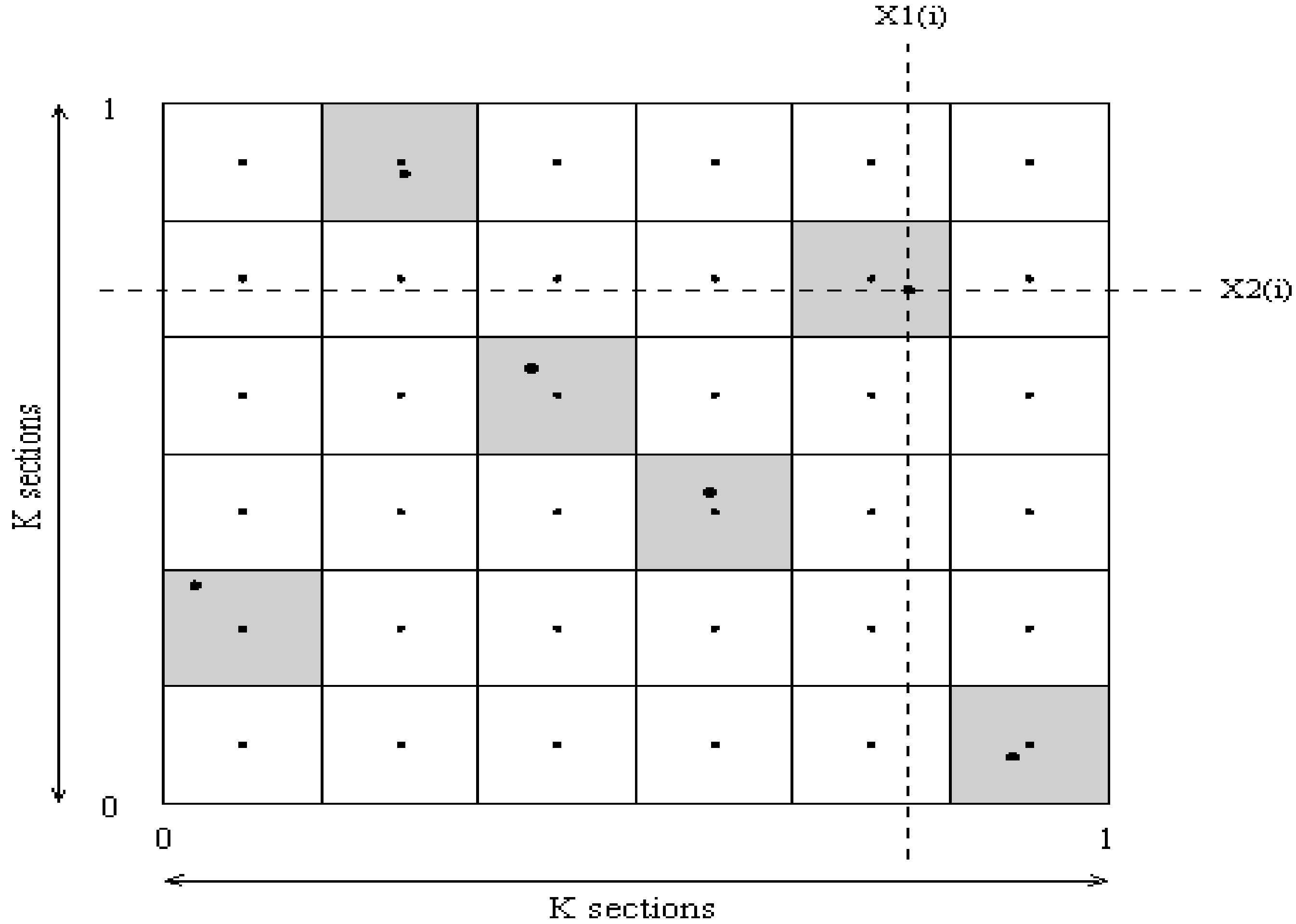
1. The two dimensional cube (square) is evenly divided to 6×6 squares

2. Two random permutations of integers $1, \ldots, 6$ select 6 squares, such that in each column and row, there is one and only one selection

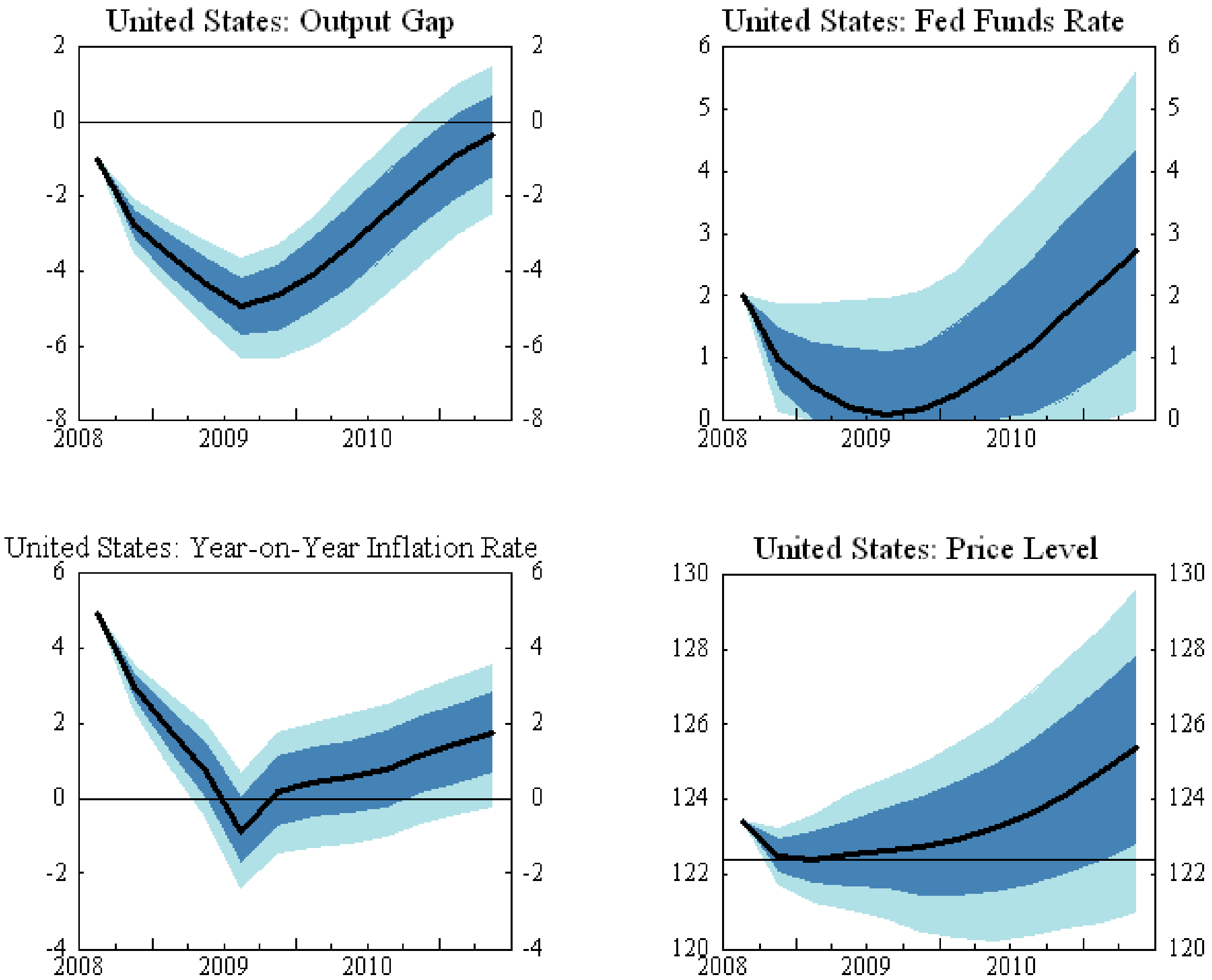
3. Each center of the selected squares is jittered by a uniform distribution

4. In this way we obtain 6 draws $[X1(i), X2(i)]$ for $i = 1, \ldots, 6$

Latin Cube Sampling Example Illustration



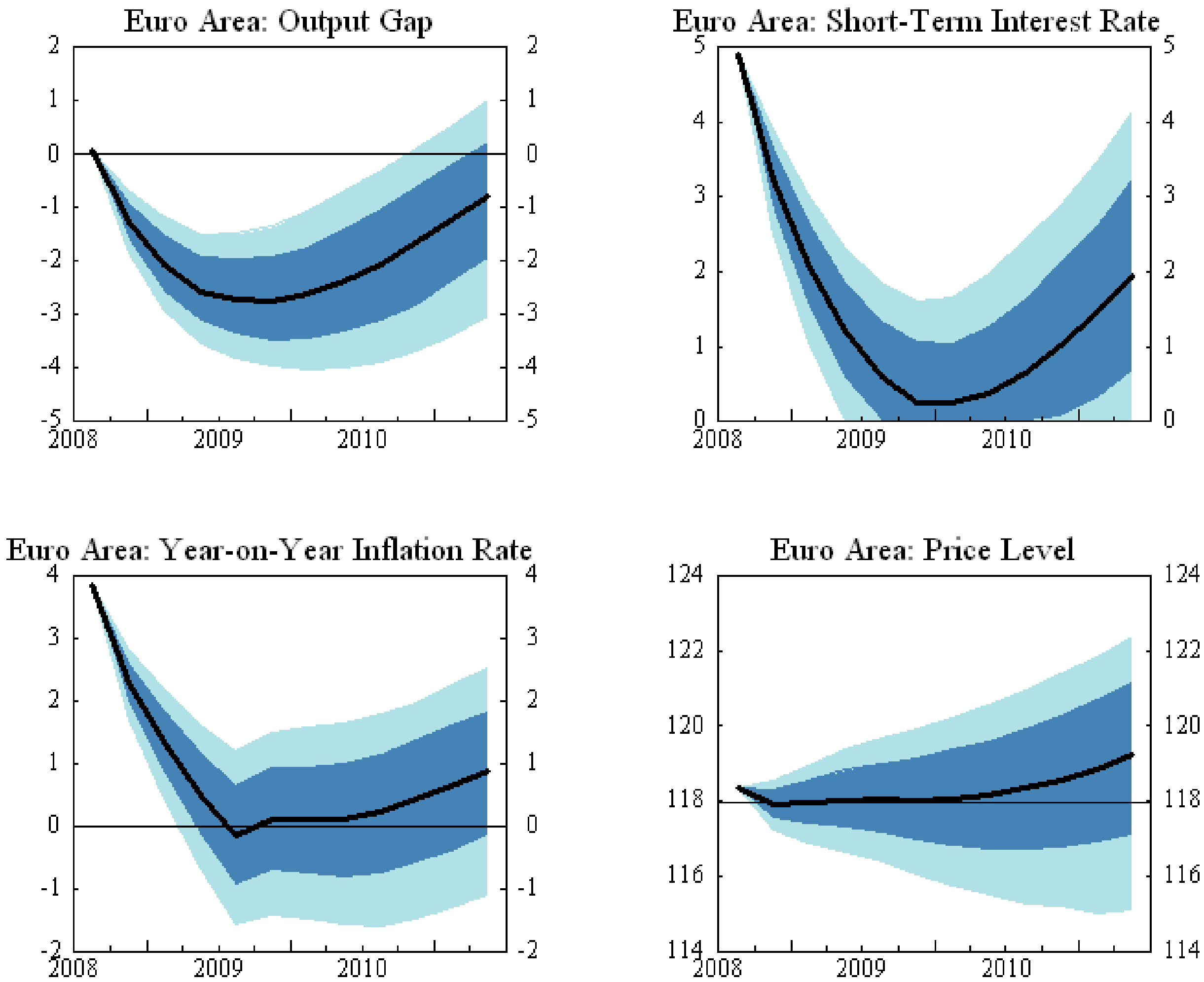
Confidence Intervals for Baseline Model: United States



Severe increases in BLT over the last several quarters and falling oil prices suggests the policy rate will hit the ZIF in the U.S.

And that there are significant risks of deflation over the next 3 years.

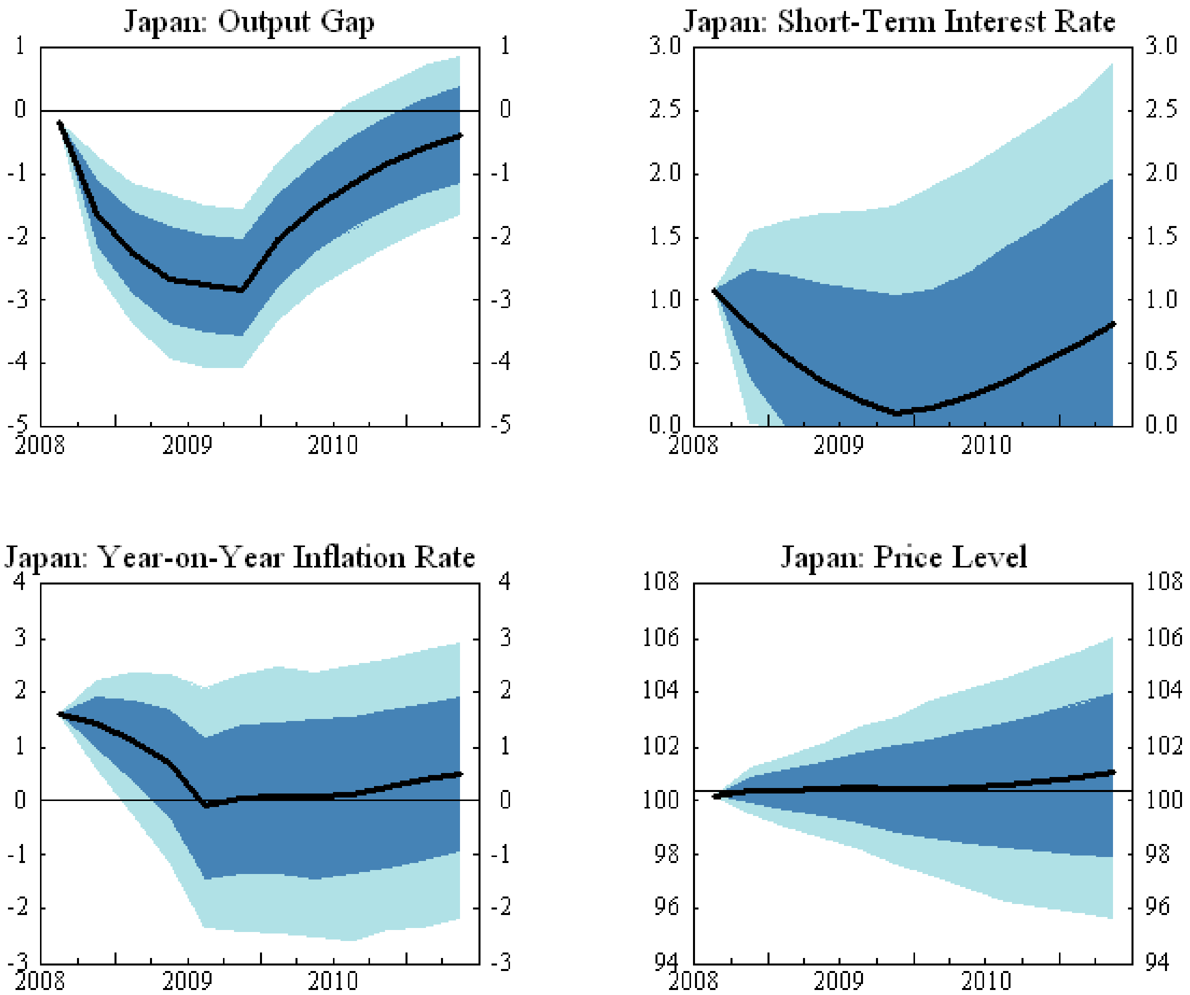
Confidence Intervals for Baseline Model: Euro Area



The ECB has recently begun to cut interest rates in line with the baseline forecast, but there is significant weakness in the pipeline.

And also significant risks of deflation over the next 3 years.

Confidence Intervals for Baseline Model: Japan

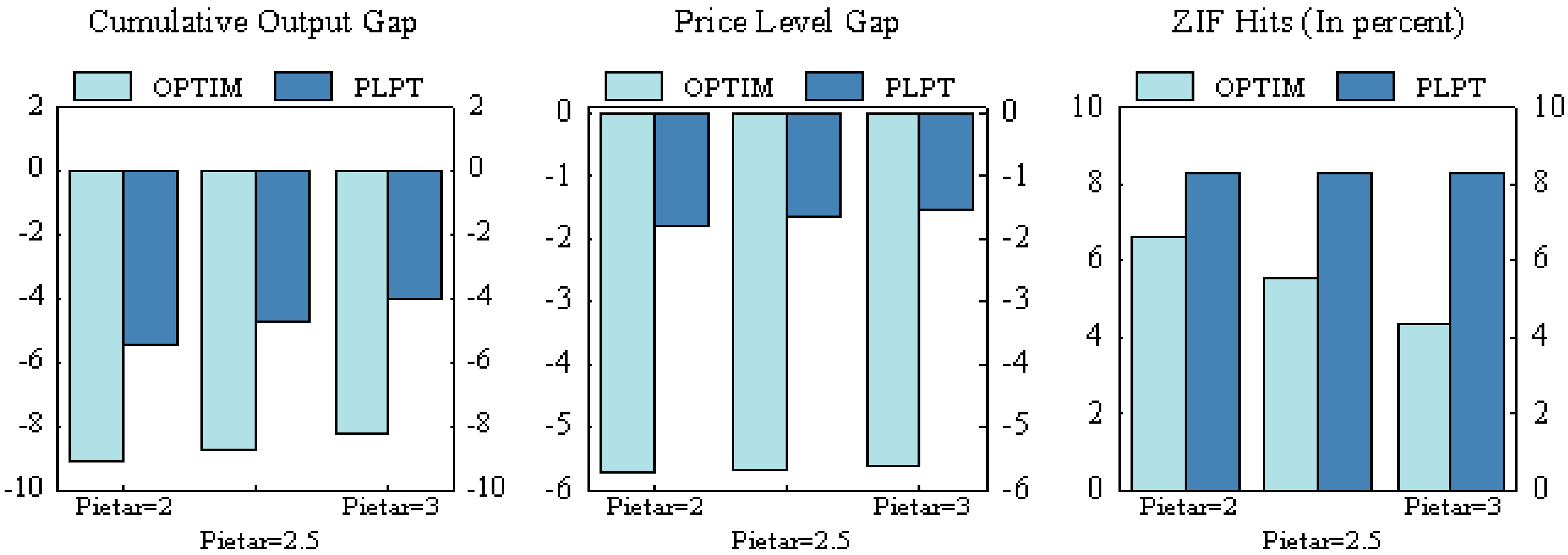


Inflation and interest rates were already very low in Japan.

So there are even greater risks of deflationary pressures reemerging.

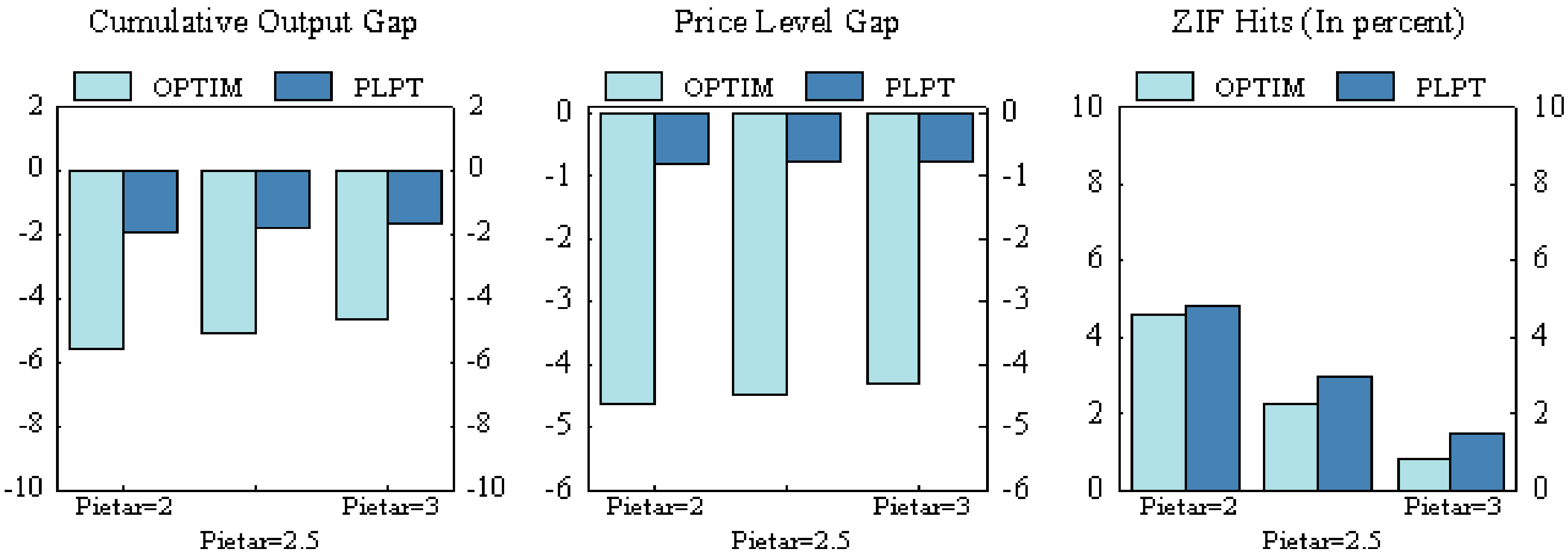
Summary Results for 3-year Simulation Period: United States

[redacted]



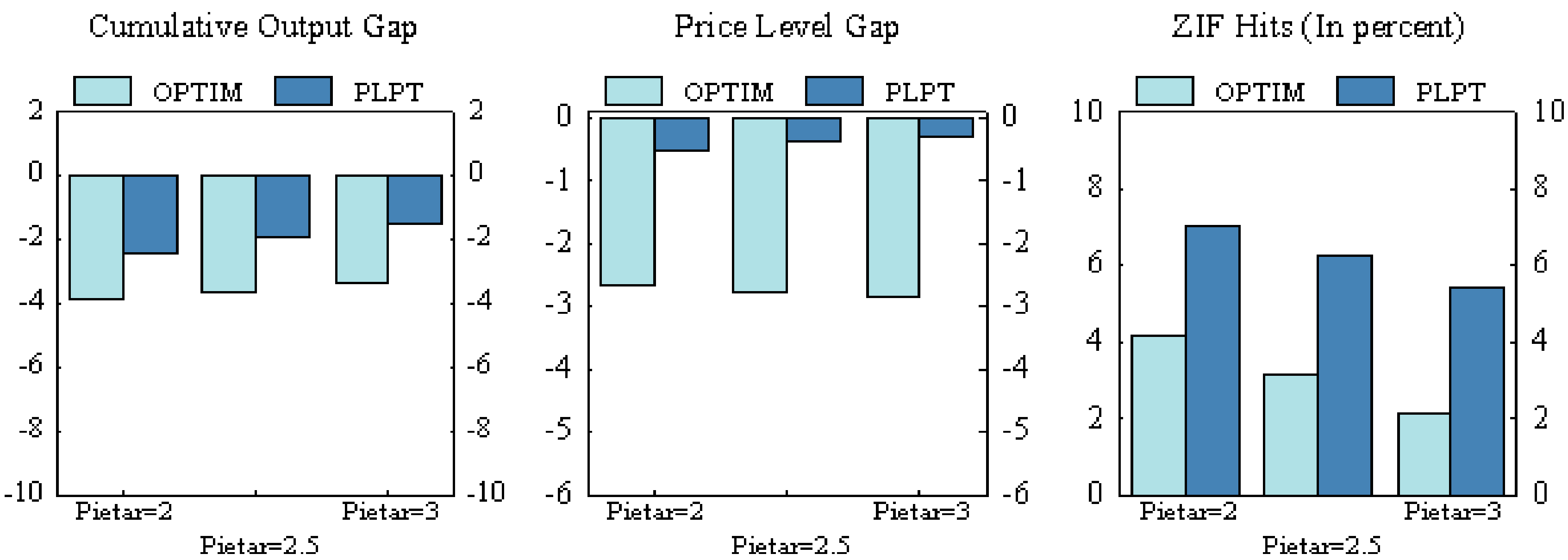
Cumulative annual output gap is smaller under PLPT.

Summary Results for 3-year Simulation Period: Euro Area



which is even better for the euro area....

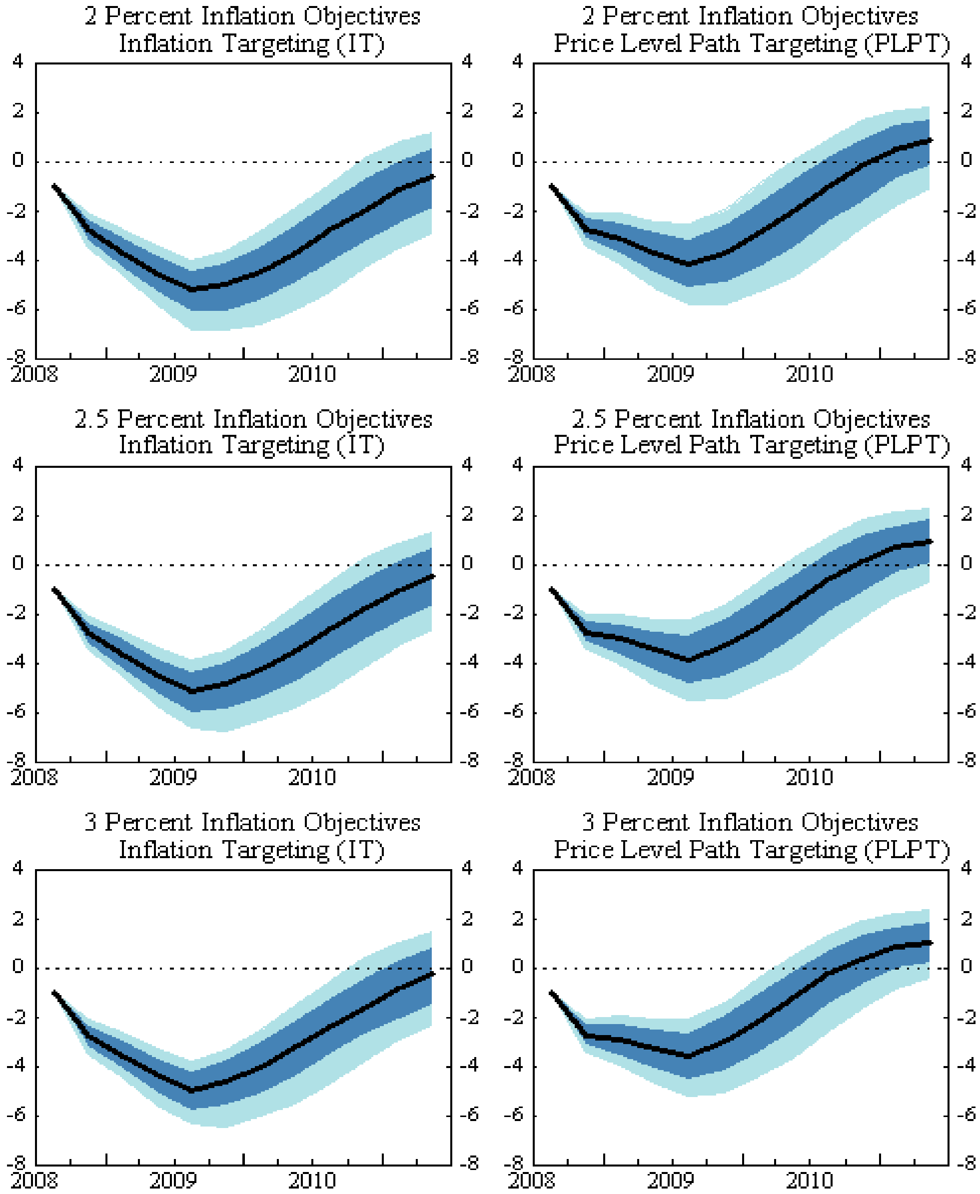
Summary Results for 3-year Simulation Period: Japan



and even better for Japan.

United States: Output Gap

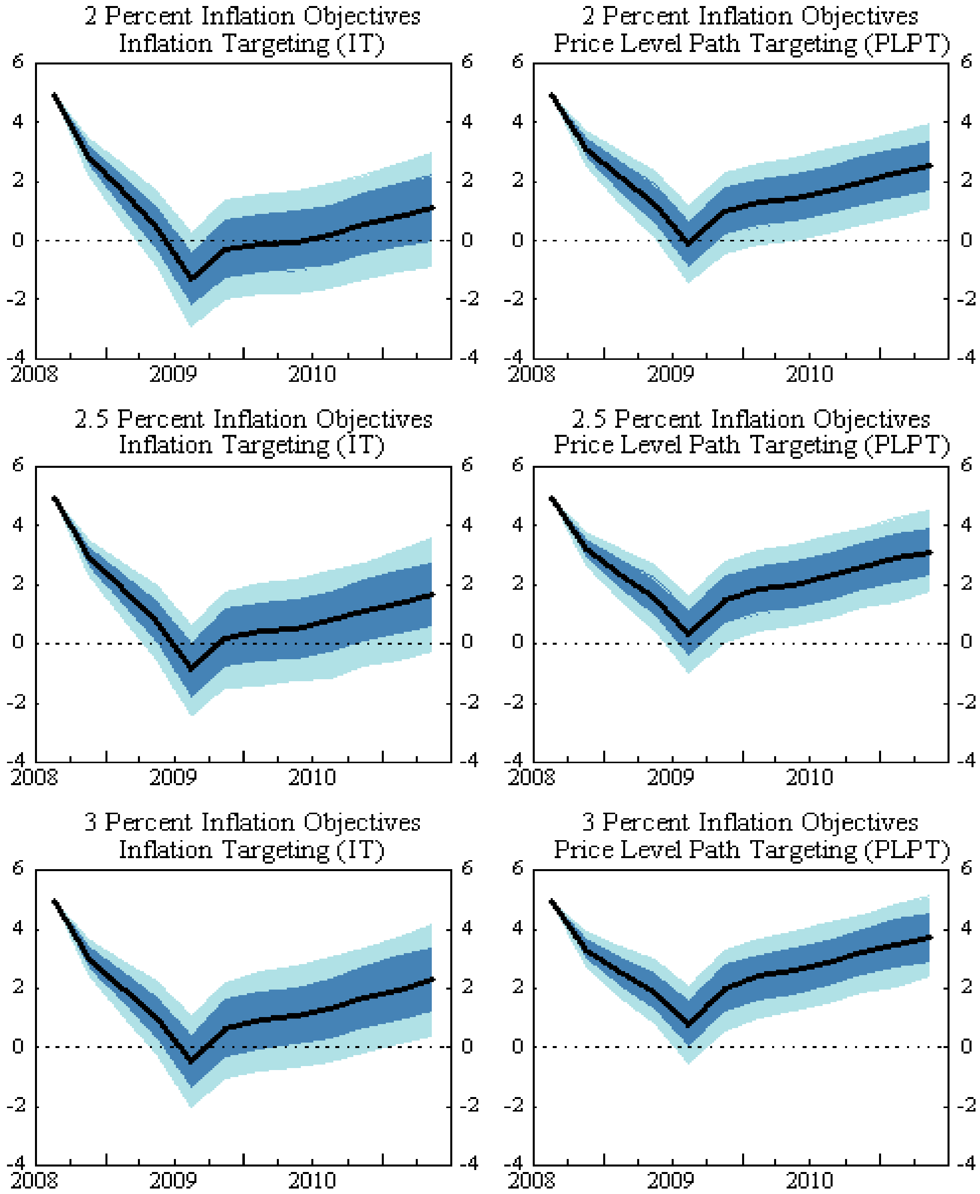
[redacted]



Inflation rises by more under the PLPT rules.

This is good!.

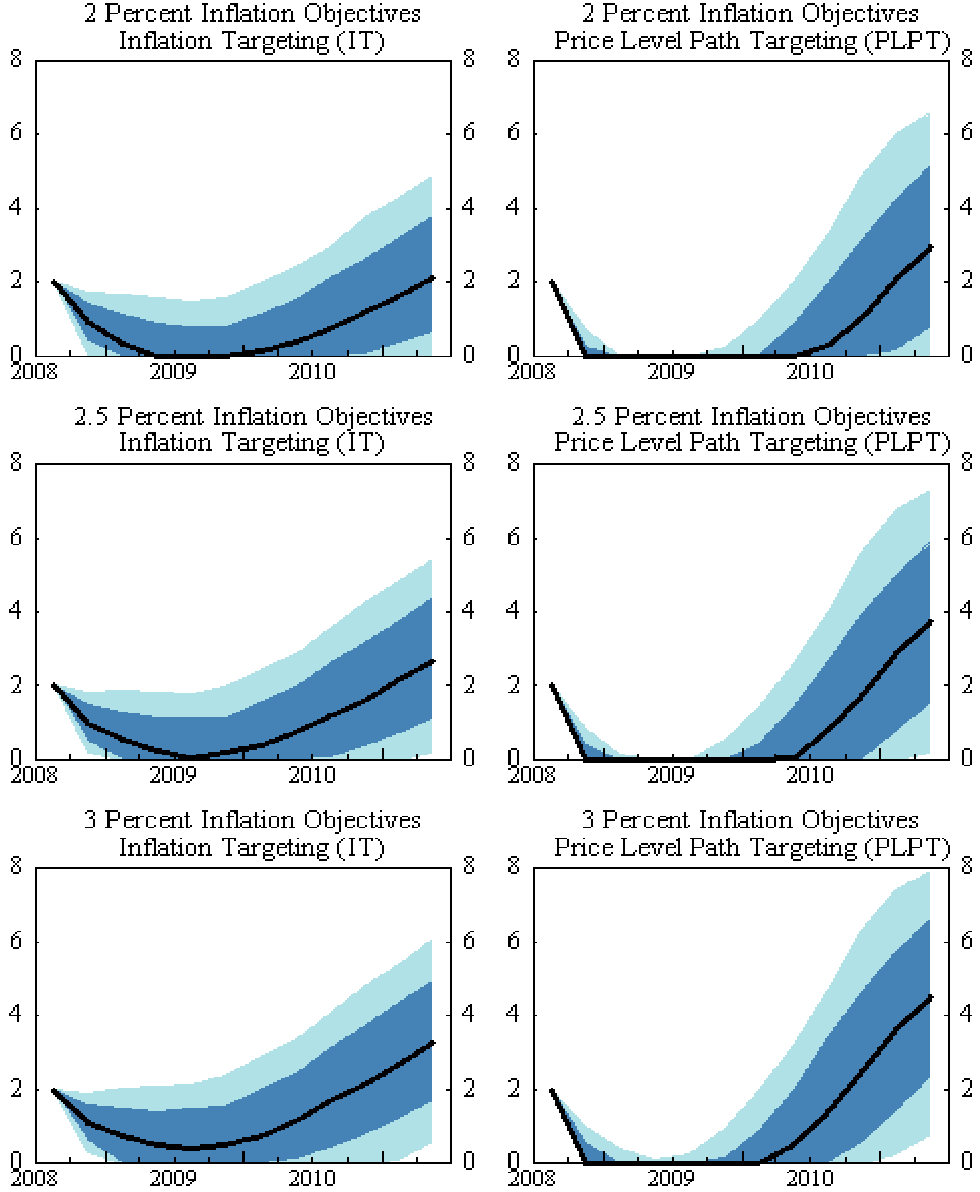
United States: Year-on-Year Inflation Rate



Inflation rises by more under the PLPT rules.

This is good!

United States: Fed Funds Rate



Interest rates are cut more aggressively under the PLPT rules and held at zero for longer.

This is good monetary policy!

Future Work

- Extended version that distinguishes between core and headline inflation.

- Add a measure of the fiscal stance to the output gap equation to consider the implications of supportive fiscal policies.

- Add a term structure to consider the effects of nonconventional monetary policy instruments such as purchases of long-term treasury bills.

- Update the baseline in response to new information.

- Consider the implications of multilateral policies versus individual country policy changes. Will multilateral actions have more impact than individual country actions?