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Historically-Determined Inflation in the Context of Price Level and Inflation Targeting Regimes

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I. Introduction

This memo is provided to the Committee to help gauge the inflation environment that is likely to surround state-contingent price level objective policy, such as the one outlined by President Charles Evans in his September 14, 2010 memo. It also compares that environment with one generated by an inflation targeting regime. We make no attempt to analyze the impact of the policy on economic outcomes and welfare. Instead, we characterize the range of probable inflation rates that would prevail over the medium run under the current stance of monetary policy and suggest that these projections might provide reasonable "lower bound" estimates for a future targeting regime *if that policy regime does not significantly alter the existing inflation outlook*. We use a standard reduce-form Bayesian vector autoregression to produce the range and likelihoods of inflation outcomes.

Our main conclusions are as follows:

- A price level target based on 2% inflation results in an inflation rate between 2.8% and 3.5% when the target is attained, and a rate one year later between 2.5% and 4.8%.[1]
- An inflation target of 2% annually results in an inflation rate of between 2.1% and 2.5% when the target is reached, and between 1.8% and 4.0% one year later.
- Potential advocates of targets for either a price level or an inflation rate should be aware of the size and range of possible inflation rates that are likely to accompany these policies.

II. The BVAR Projection

To produce our forecast, we use a medium-scale (15-variable) Bayesian vector autoregressive (BVAR) model. Our principle variable of interest is the core personal consumption expenditures (PCE) price index, but naturally the model produces forecasts for all other variables in the model that help predict inflation. We choose a model in the BVAR class for three principle reasons. First, BVARs allow one not only to predict the most likely forecast path for the variables, but also easily enable one to construct a complete probabilistic statement of the uncertainty surrounding that forecast. Second, models of this type have recently been shown to outperform a number of popular alternatives in terms of forecast accuracy.[2] Finally,

[1] All inflation rates in this memo are expressed as four-quarter percent changes.

[2] See Banbura, Giannone, and Reichlin (2010) and Koop (2010).

the results of these models are easily reproduced. The specific features of our model are described in the Explanatory Notes at the conclusion of this memo.

The likely forecast path of a variable and the likelihoods of the alternatives are described by a predictive density. It is as natural instrument to evaluate the likelihood of alternative outcomes for targeting regimes whether expressed in price levels or inflation rates, provided that inflation and inflation expectations dynamics are not appreciably altered by the change in policy regime. Of course, we recognize that the principle advantage of explicit target policies is precisely to alter inflation expectations by exploiting some capacity for a central bank to commit itself to a future course of state-contingent actions. It is likely that today's inflation dynamics already reflect some degree of acceptance of inflation targeting given the Committee's communications over the last few years, but a price level target would be largely unanticipated. In this regard, the comparisons can be understood as a "worst-case" scenario in which the policy fails in its principle advantage, and historical inflationary forces dominate.

The BVAR forecast runs from the third quarter of 2010 through the fourth quarter of 2020.[3] Figure 1 shows the forecast for core PCE inflation along with the fan chart implied by the predictive density at each date; the fan chart is rendered with 10th percentile increments so that core PCE inflation falls within the entire shaded region with 90% probability. After falling for the first two quarters of the forecast period, core PCE inflation (year-on-year basis) gradually returns to historical trend values. Figure 2 superimposes the BVAR forecast on the Tealbook's September forecast along with the 70% probability bands from each. In contrast to the BVAR forecast, core PCE inflation expected by the Tealbook continues to fall though 2012 leaving it below the Committee's objectives for the duration of the forecast (which ends in 2014). The BVAR forecast is more sanguine in that core PCE inflation returns to a mandate consistent 1.7-2.0% range by mid-2012. Nevertheless, the Tealbook forecast falls comfortably in the BVAR 70% probability bands implying that the two forecasts are not radically divergent.[4]

Figure 2 shows the core PCE price levels implied by the BVAR inflation forecast versus two price level targets. The upper one corresponds to a constant 3% inflation rate beginning in the fourth quarter of 2007 and the other to a steady 2% inflation beginning at the same time. Even though the BVAR expected inflation rate forecast looks acceptable from a policy perspective, it implies an expected path for the price level that remains below the 2% target level for the next ten years. This reflects the large amount of inflation persistence evident in the historical data. In terms of possible outcomes, roughly 50% of price paths breach the 2% target level in the next ten years with the other half falling short, and roughly one-third of outcomes

[3] Observations for third-quarter high-frequency financial variables were imposed directly on the forecast.

[4] The wider probability bands of the BVAR forecast implies more forecast uncertainty when compared to the Tealbook. This is due to a fundamental difference in methods. In addition to stochastic variation in the economic environment that cannot be captured by the model, Bayesian techniques allow for uncertainty in the parameters of the model itself.

attain the 3% target level. In what follows, we confine the discussion to the 2% path, since the 3% path appears too strenuous a target in the context of the BVAR forecast.

III. Price Level/Inflation Comparisons

To evaluate a state contingent, price level targeting regime, it is useful to get an idea of the inflation rates that can be expected when the predetermined price level path or inflation target is breached. Ideally, a forecasting model that clearly articulates the structure of the economy including the formation of inflation expectation and the policy regime would be applied to answer these questions; however the perfect-foresight general-equilibrium models available to us result in unrealistically quick movements in inflation. In the strictest sense, using the BVAR estimates shown here assumes that a new policy regime would not alter the predictive densities. Nevertheless, the BVAR forecasts can be informative, especially because the policy is designed to guide inflation expectations, and hence actual inflation, higher. Since the model does not capture these forces, our inflation forecast, at least in the near-to-medium term, is likely to be biased downward.

Figure 4a shows the predictive density of year-on-year core PCE inflation in the fourth quarter of 2012 conditional on the 2% price level target having been attained on or before that date. In these circumstances, the median forecast is 3.0%, and inflation falls between 2.8% to 3.5% with 70% probability. This compares to the unconditional point forecast of 1.9%. Since evidence suggests that inflation displays considerable persistence, it is worthwhile to ask what becomes of inflation on these same paths, but one year later. Figure 4b indicates that the median inflation rate rises to 3.6% with the 70% probability band between 2.4% and 4.8%. We ran the same exercise using later dates for price level target attainment; the pattern is quite consistent although the point estimates are all higher.[5]

We also considered, for comparison purposes, BVAR estimates for inflation rates when an inflation target (not a price level target) of 2% is breached. Figure 5a shows the predictive density of core PCE inflation for all paths that attain a 2% rate by the end of 2012; the median inflation rate is 2.2% and is framed by a narrow probability band one-half of a percentage point wide. Although the federal funds rate remains exceptionally low on the median path, Figure 5b shows that the median inflation rate one year out rises to just 2.8%—roughly one percentage point lower than those produced with a price-level target.

IV. Conclusion

We have proposed a simple method to gauge the inflation implications of a state-contingent price level and inflation targets using a standard reduce-form Bayesian vector auto regression.

[5] We excluded this figures from the memo for brevity, but they are available on request.

Although it cannot capture the novel inflation dynamics resulting from a switch in the monetary policy regime, we think that it provides a useful lower bound on expected near- and medium-term inflation rates. Our results indicate that a price level target defined by the constant 2% inflation path is likely to produce a substantial overshooting of 2% inflation, with the median forecast reaching at rate of 3% at the crossing and 3.6% one year later. Overshooting also occurs in this environment when a 2% inflation rate target is met, but the levels of inflation are notably lower. Of course, overshooting is a necessary consequence of the state-contingent price level targeting policy. We hope that our results provide a fruitful first step at gauging the amount of overshooting that can be expected and the level of uncertainty that must be tolerated.

Explanatory Notes

A Medium Scale BVAR Model

We produced the point forecast and predictive densities using a fifteen variable, reduced-form Bayesian vector autoregression (BVAR) estimated at the quarterly frequency. The model includes three of the four variables that are submitted to the Federal Open Market Committee four times a year: real GDP, the unemployment rate, and the core personal consumption expenditures (PCE) price index. Labor productivity, labor compensation (which together imply unit labor costs), and the federal funds rate are included to help capture the essence of a new-Keynesian inflationary process. The model also includes yields on 10-year U.S. Treasuries and AAA rated corporate debt to provide information on term and credit spreads. The S&P 500 equity price index and the S&P500 dividend yield round out the list of financial variables. The remaining variables are personal consumption expenditures, government purchases, the producer price index for industrial materials, and a trade-weighted nominal exchange rate.

Each variable enters the system in log-level form and there are four lags of each variable in each of the 15 equations (in addition to a constant). Bayesian shrinkage is used to reduce degradation of forecast performance due to overfitting. We use a normal inverted Wishart prior that retains the basic properties of the traditional Minnesota prior: coefficients on the first own lags are shrunk toward one and all others to zero and recent lags are more important than distant ones so that the prior coefficient variances are smaller for distant lags. We also use the "inexact differencing" prior that shrinks the sum of the own lag coefficients toward one.[6] We set the hyperparameters that control the overall tightness of each set of priors to optimize forecast performance during the 2009Q3–2010Q2 period. The model is estimated using data from the 1960Q1–2010Q2 period. Finally, the predictive densities are computed with 2000 draws from the posterior distribution of parameters and 2000 histories of innovations for a total of 40,000 separate projections.

REFERENCES

Banbura, Marta, Domenico Giannone, and Lucrezia Reichlin (2010). "Large Bayesian Vector Auto Regressions," *Journal of Applied Econometrics*, 25, 71-92.

[6] The prior distributions are set forth in Sims and Zha (1998) and explained in the context of a complete forecasting exercise in Robertson and Tallman (1999). We follow Banbura, Giannone, and Reichlin (2010) in our implementation of the priors.

Koop, Gary (2010). "Forecasting with Medium and Large Bayesian VARs," University of Strathclyde *working paper*.

Robertson, John C. and Ellis W. Tallman (1999). "Vector Autoregressions: Forecasting and Reality," Federal Reserve Bank of Atlanta *Economic Review*, (Q1), 4-18.

Sims, Christopher A. and Tao Zha (1998). "Bayesian Methods for Dynamic Multivariate Models," *International Economic Review*, 39, 949-68.

Figure 1: BVAR Estimated Inflation Fan Chart

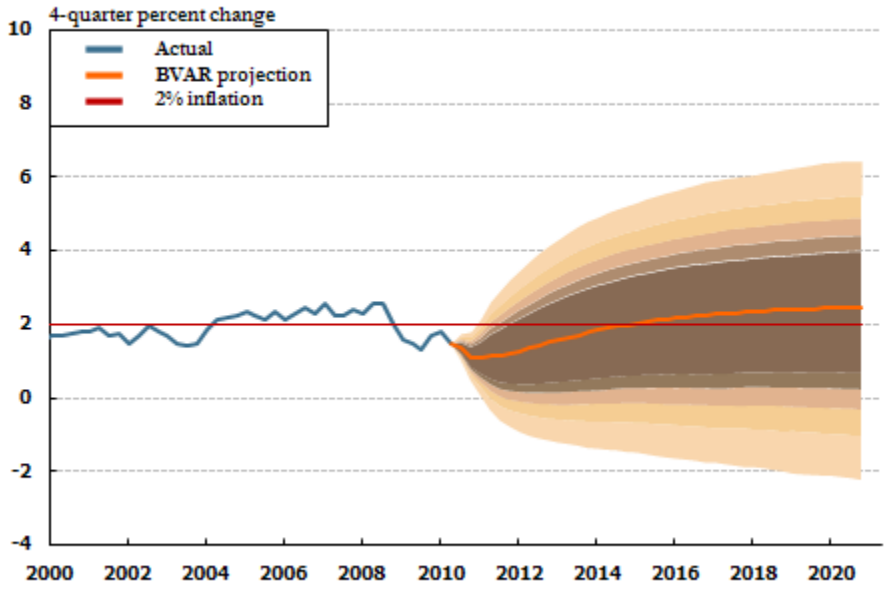

Figure 2: Greenbook Forecast Range Similar to BVAR

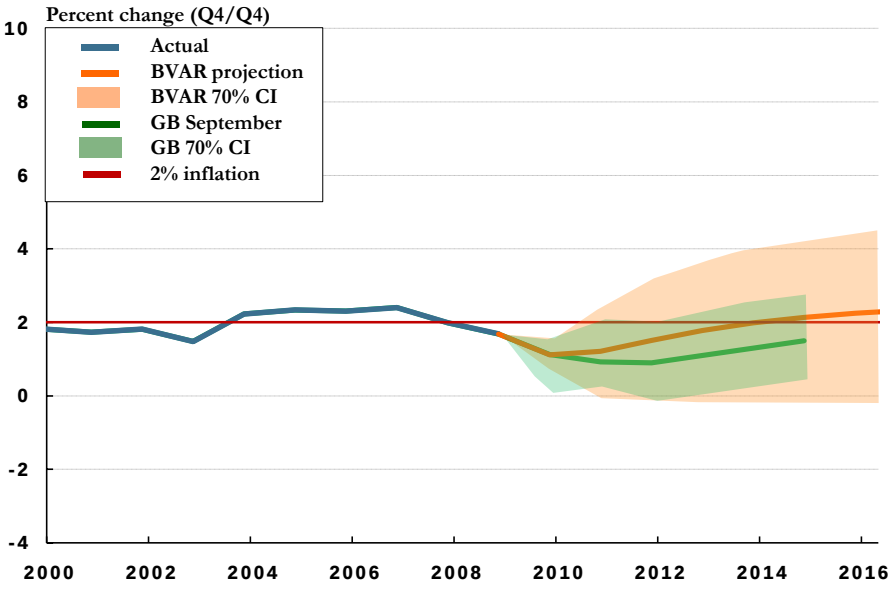

Figure 3: Price Level Targets Applied to BVAR Predictions

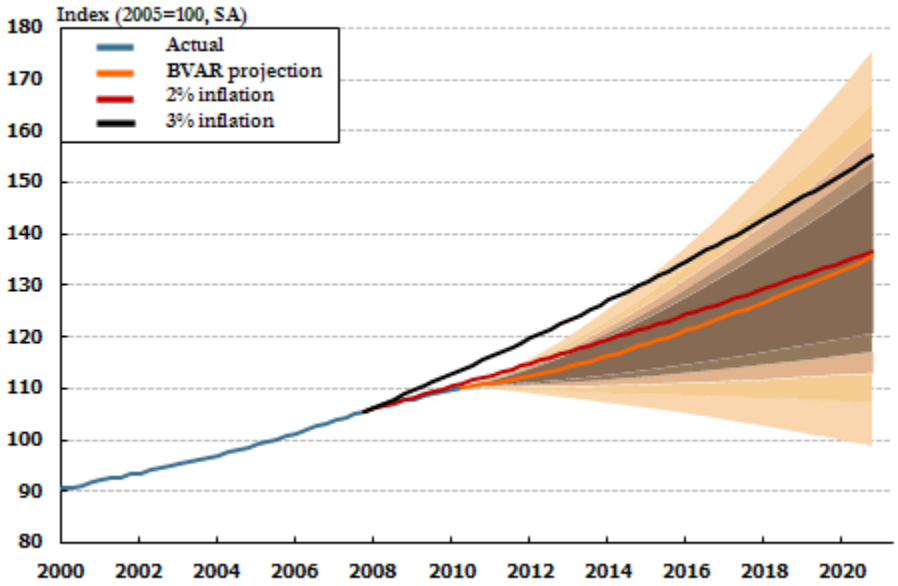

Figure 4a: Core Inflation Rates at Breaching: Cases which Breach a 2% Price Level Target Path by 2012

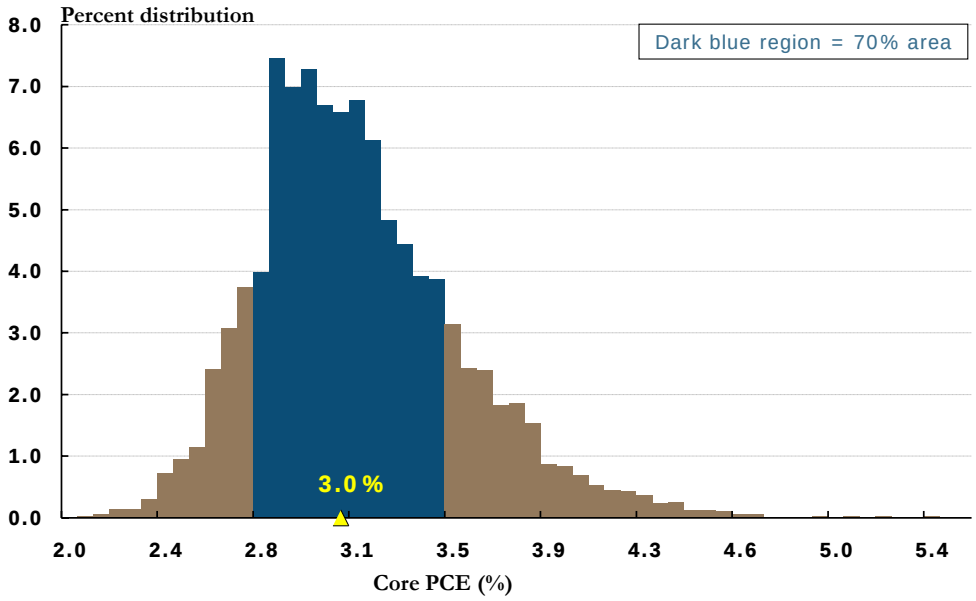

Figure 4b: Core Inflation Rates One Year Later: Cases which Breach a 2% Price Level Target Path by 2012

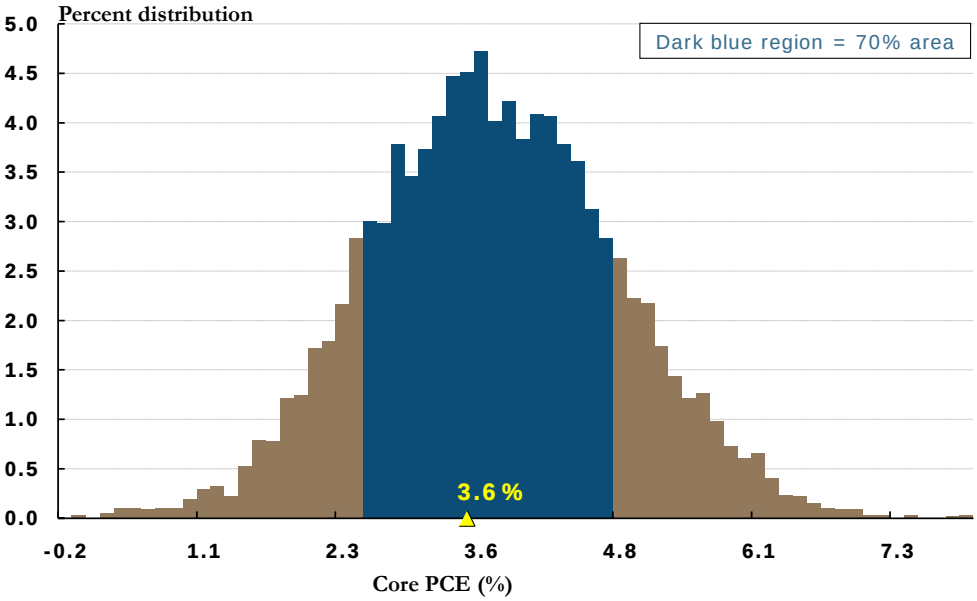

Figure 5a: Core Inflation Rates at Breaching: Cases which Breach a 2% Annual Inflation Target by 2012

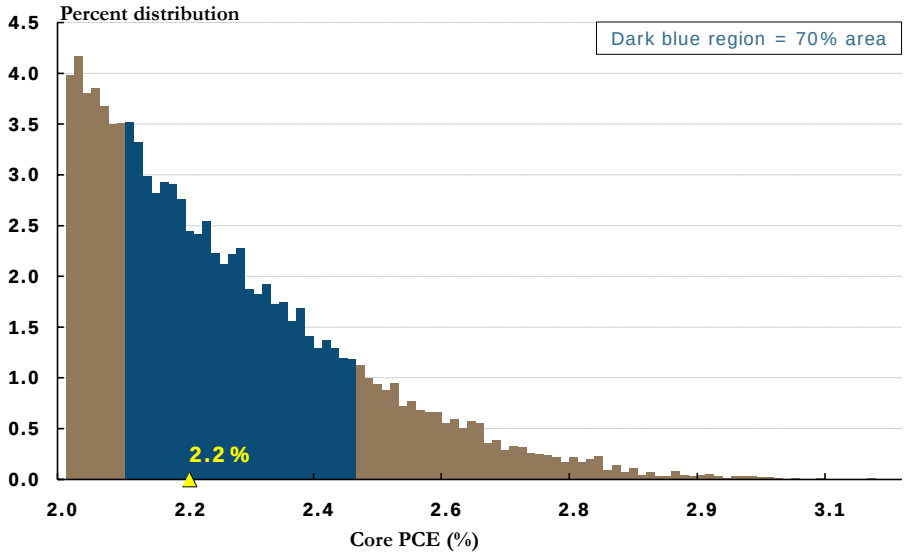

Figure 5b: Core Inflation Rates One Year Later: Cases which Breach a 2% Annual Inflation Target by 2012