

BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM
DIVISION OF MONETARY AFFAIRS
FOMC SECRETARIAT

Date: March 7, 2014
To: Federal Open Market Committee
From: Matthew M. Luecke
Subject: DSGE Models Update

The attached memo provides an update on the projections of the DSGE models.

System DSGE Project Forecasts

March 7, 2014

Jeffrey R. Campbell¹

Federal Reserve Bank of Chicago

¹ I thank Marc Giannoni, Argia Sbordone, Keith Sill, Hess Chung, and Dario Caldara for their contributions.

This memo describes the economic forecasts for three of the four models that make up the System dynamic stochastic general equilibrium (DSGE) project. These three are the New York model, Philadelphia's PRISM model, and the Board's EDO model. Chicago's model is undergoing substantial revision at this time, and so that team has chosen not to submit a forecast. The forecasts are all based on NIPA releases through the 2013:Q4 second estimate release from February 2014 and all use projections for 2014:Q1 based on available high-frequency data. All of the models use financial-market expectations to determine the path of the fed funds rate over the near term. The model forecasts all begin in 2014:Q2 and extend through 2016:Q4. The table at the end of this introductory section presents the models' forecasts for Q4/Q4 GDP growth, year-on-year inflation, and the year-end fed funds rate over this horizon. The accompanying figure plots the underlying quarterly forecasts.

In the previous DSGE memo (December 2013) the median growth forecast for 2014 was 2.4 percent, and the median inflation forecast was 1.0 percent. Excluding the Chicago model, these medians were 2.0 and 1.1 percent. The incoming data raised these median forecasts only slightly to 2.1 and 1.2 percent respectively. Similarly, the models' projections for the fed funds rate path are about unchanged from the previous memo.

Two of the three models, EDO and PRISM, forecast steady increases in output growth over the forecasts' out years, 2015 and 2016. Both models feature about 80 basis point increases from 2014 through 2016. In contrast, the New York model remains pessimistic about output growth, with its forecast remaining at about 2.0 percent over the entire horizon. In the EDO model, the higher output growth reflects a return to normal conditions after a set of adverse financial-market shocks in 2014, while in PRISM the same effect arises from a recovery of hours worked driven by waning investment and financial shocks. The New York model anticipates very different impacts of these same factors on growth. Its projections of hours worked decline and investment shocks remain a drag. Furthermore, the effects of past forward guidance on output's level have begun to shrink, pulling down anticipated output growth.

Regarding inflation, all three models predict it to grow but still remain well below the 2.0 percent target at the end of 2016. In the New York and PRISM models, the anticipated

progress arises from the diminishing effects of adverse financial shocks and shocks to the marginal efficiency of investment. In EDO, the same progress reflects the waning of previous shocks that reduced producers' markups.

The remainder of this memo contains more detailed descriptions of the three models' forecasts.

Forecast Summary

Model	Output Growth (Q4/Q4)					
	2014		2015		2016	
	Mar	Dec	Mar	Dec	Mar	Dec
EDO - Board of Governors	2.1 (-1.0,4.9)	1.9 (-1.6,5.1)	2.5 (0.5,4.3)	2.7 (0.9,4.5)	3.0 (1.0,5.0)	3.3 (1.3, 5.3)
New York Fed	2.0 (-0.1,3.4)	2.0 (-0.9,3.9)	1.9 (-1.3,4.6)	1.7 (-1.8,4.5)	1.9 (-1.2,5.0)	1.7 (-1.5,5.0)
PRISM - Philadelphia Fed	3.4 (1.2,5.9)	3.6 (0.4,6.7)	4.2 (0.8,8.0)	3.9 (0.3,7.6)	4.1 (0.6,7.9)	3.9 (0.3,7.7)
Chicago Fed		2.7		3.0		3.1
Median Forecast*	2.1	2.4	2.5	2.8	3.0	3.2

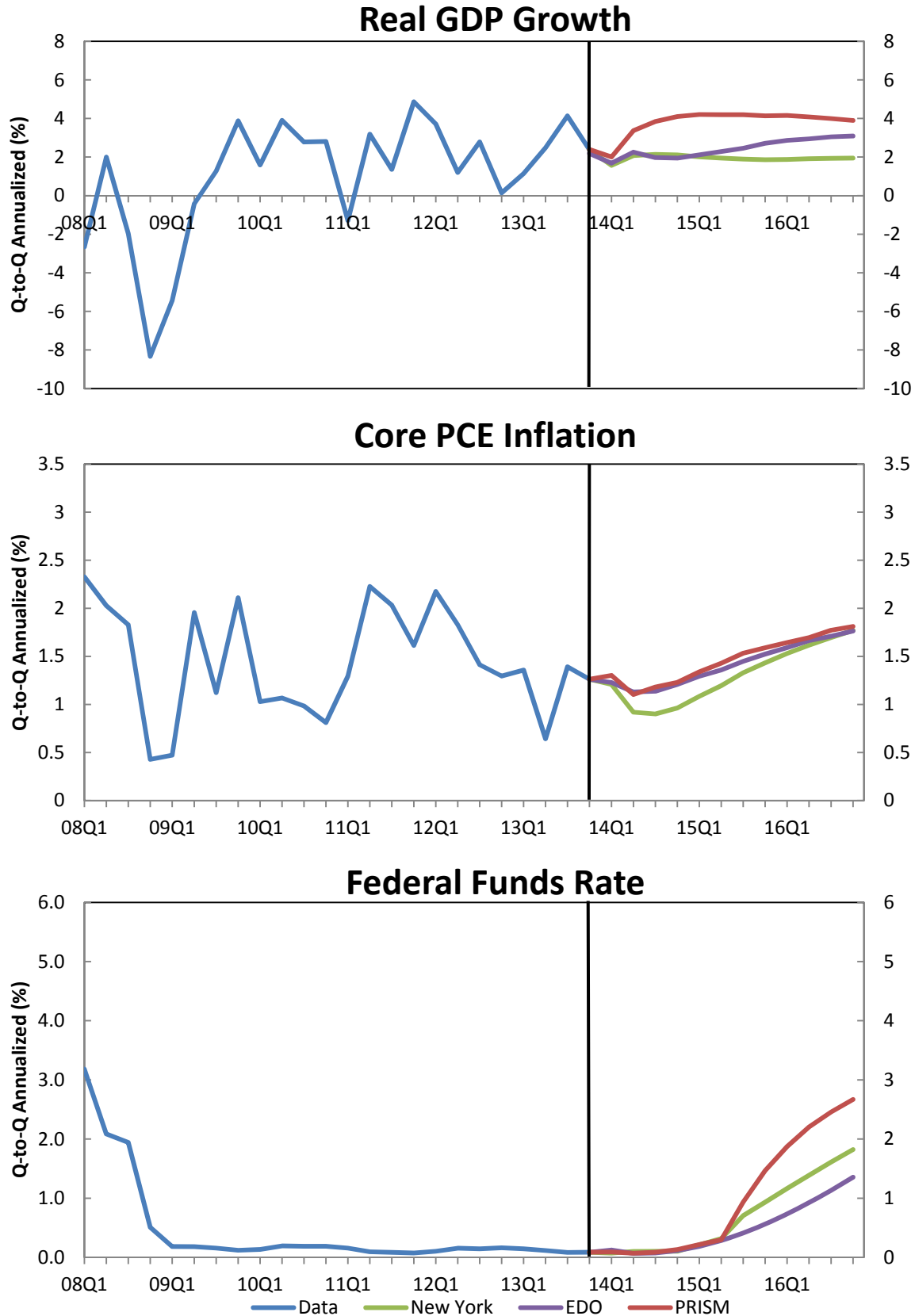
Model	Inflation (Q4/Q4)					
	2014		2015		2016	
	Mar	Dec	Mar	Dec	Mar	Dec
EDO - Board of Governors	1.2 (0.5,1.6)	1.1 (0.5, 1.7)	1.4 (0.7,2.1)	1.4 (0.7, 2.1)	1.7 (0.9,2.5)	1.6 (0.8, 2.5)
New York Fed	1.0 (0.5,1.4)	0.9 (0.3, 1.5)	1.2 (0.4,1.9)	1.3 (0.4,2.0)	1.6 (0.8,2.4)	1.7 (0.8, 2.4)
PRISM - Philadelphia Fed	1.2 (0.3,2.1)	1.4 (0.2, 2.7)	1.5 (0.0,3.1)	1.6 (-0.1, 3.2)	1.7 (0.0,3.5)	1.8 (0.1, 3.6)
Chicago Fed		0.5		0.5		0.9
Median Forecast*	1.2	1.0	1.4	1.3	1.7	1.6

Model	Federal Funds Rate (Q4)					
	2014		2015		2016	
	Mar	Dec	Mar	Dec	Mar	Dec
EDO - Board of Governors	0.3 (0.0,1.2)	0.3 (0.0, 1.5)	0.8 (0.0,2.3)	0.8 (0.0, 2.4)	1.5 (0.2,3.1)	1.4 (0.2, 3.1)
New York Fed	0.1 (0.1,1.0)	0.1 (0.3,1.1)	0.9 (0.2,2.1)	0.9 (0.3, 2.2)	1.8 (0.6,3.2)	1.9 (0.7,3.3)
PRISM - Philadelphia Fed	0.1 (-1.1,1.3)	0.1 (-1.3,1.6)	1.5 (-0.7,3.7)	1.6 (-0.7, 4.1)	2.7 (-0.1,5.4)	2.9 (0.1,5.9)
Chicago Fed		0.1		0.5		1.4
Median Forecast*	0.1	0.1	0.9	0.9	1.8	1.7

For each individual forecast, the numbers in parentheses represent 68% confidence bands.

* The median forecast is calculated as the median of the Q4/Q4 projections from the forecasters.

Quarterly Forecast Paths



The New York Model

The FRBNY model forecasts are obtained using data released through 2013Q4, augmented for 2014Q1 with the FRBNY staff forecasts for real GDP growth, core PCE inflation, and growth in total hours, and with values of the federal funds rate and the spread between Baa corporate bonds and 10-year Treasury yields based on 2014Q1 observations. The expected federal funds rate is constrained to equal market expectations, as measured by OIS rates, through 2015Q2. This constraint is implemented via anticipated policy shocks, whose standard deviations are estimated using FFR expectations since 2008Q4, when the zero bound became binding. The 2014Q1 staff projections and OIS rates are those that were available on March 4, 2014.

Relative to December, the GDP growth forecast for 2014 (Q4/Q4) remains unchanged at 2.0 percent, while the forecasts for 2015 and 2016 (Q4/Q4) are higher by two tenth of a percent, at 1.9 percent, compared to last December's forecast of 1.7 percent for each of these years. In general, the model continues to project moderate growth in economic activity throughout the forecast horizon. For inflation, the mean core PCE inflation for 2014 is projected to be 1.0 percent, slightly higher than the 0.9 percent projected last December. For 2015 and 2016, however, inflation forecasts are lowered to 1.2 and 1.6 percent, respectively, compared to the December forecasts of 1.3 and 1.7 percent, respectively. Despite being on an upward trajectory, inflation is projected to remain below the FOMC long-run goal of 2 percent throughout the whole forecast horizon.

Uncertainty around real GDP growth and inflation forecasts has diminished slightly, due primarily to a reduction in downside risks. For GDP growth, the 68 percent bands cover the intervals -0.1 to 3.4 percent in 2014, -1.3 to 4.6 percent in 2015 and -1.2 to 5.0 in 2016. For inflation, the 68 percent probability bands range from 0.4 to 2.4 percent throughout 2016.

The FRBNY forecast is driven by three main factors. First, headwinds from the financial crisis, as captured by shocks to the marginal efficiency of investment (MEI), continue to depress real

activity, and hence result in low real marginal costs, and low inflation, five years after the crisis. The economy experienced large credit spread shocks during the Great Recession and a sequence of adverse MEI shocks afterwards. Given that the MEI shocks have persistent effects on output growth and inflation, they continue to negatively affect the forecasts for these variables through the end of the forecast horizon. Second, while accommodative monetary policy, particularly forward-guidance, has played an important role in counteracting these headwinds, and has lifted output and inflation in past years, the impact of past forward guidance announcements on the *level* of output has now begun to wane. This implies a negative effect of policy on GDP *growth*, starting in 2014 and for the remainder of the forecasting horizon. Third, the model estimates that reductions in labor supply will also contribute to lower GDP growth. Combining these three factors explains why output growth is still below its long-run average at the end of 2016.

The FRBNY model projects the FFR to be roughly 2 percent by the end of 2016, about 2 percentage points below its steady state value. This forecast is mostly driven by the endogenous response of policy to the weak economy, rather than by policy shocks. In fact, about two thirds of the FFR deviation from steady state (close to 1.5 percentage points) is accounted for by the negative contribution of MEI shocks, while anticipated policy shocks add about 70 basis points of accommodation. In this respect, the DSGE forecast is quite consistent with the December Summary of Economic Projections (SEP), which show a majority of FOMC participants expecting the FFR to be at or below 2% in 2016, while inflation and unemployment are projected to be close to target. Unlike the SEP, however, the large and persistent undershooting of the longer-run level of the FFR in the model is not sufficient to achieve the Committee's objectives even by the end of 2016. Indeed, the model sees GDP growth about one percentage point below steady state, and inflation about a quarter of a percentage point below target by the end of 2016.

PRISM (Philadelphia)

The Philadelphia Research Intertemporal Stochastic Model (PRISM) forecast is constructed using data through 2013Q4 that are then supplemented with a 2014Q1 nowcast based on the most recent Macroeconomic Advisors model forecast. In addition, the forecasted path for the federal funds rate is constrained through 2015Q2 using implied expectations from futures market data.

PRISM forecasts acceleration in growth from the modest pace seen in 2013. While 2014Q1 real output growth is pinned down at 2 percent by the nowcast, the forecast calls for output growth to increase to 3.4 percent in the second quarter of 2014 and then gradually rise to a 4.2 percent pace by 2015Q1. Real GDP growth then stays near 4 percent through 2016. While output growth is projected to be fairly robust, inflation remains contained at below 2 percent through the forecast horizon. The forecast has the funds rate following financial market expectations through 2015Q2 and then rising to 1.5 percent by the end of 2015 and 2.7 percent by the end of 2016.

According to PRISM, negative shocks to TFP, investment, and labor supply are the primary factors holding down real output growth over 2013Q4 to 2014Q1. The model continues to imply a de-trended level of output that is well below its steady state. An important factor in accounting for this output gap is the low level of aggregate hours worked, which the model generates through a combination of labor supply shocks, investment shocks, and government spending shocks. Looking ahead, the model anticipates that above-trend real GDP growth will be driven by a rebound in hours worked and a waning of investment and financial shocks.

The 2014Q1 nowcast for core PCE inflation is 1.3 percent. The model then predicts a gradual but steady acceleration in core inflation over the next 3 years to a peak of 1.8 percent in 2016Q4. The principal factor accounting for below-trend core inflation over the forecast horizon is the very slow unwinding of the effects financial shocks, that are being only partially

offset by the rebound in hours worked and aggregate demand (which put upward pressure on inflation).

The forecast is implemented with a path for the federal funds rate that is constrained by financial market expectations through 2015Q2. When that constraint is lifted in 2015Q3 the funds rate rises quickly, jumping about 65 basis points in 2015Q3. By the end of 2016, the funds rate is projected to be at about 2.7 percent. The model puts relatively little weight on the output gap in the estimated policy rule: consequently, the shocks that account for the dynamics of the federal funds rate are largely the same as those that account for the dynamics of inflation.

EDO (Board)

The EDO model projects average real GDP growth below its trend of 2.7 percent until the end of 2015, while unemployment remains around 7 percent through 2016. This subdued pace of real activity is accompanied by inflation gradually accelerating from a low of 1.2 percent at 2014:Q1 to about 1¾ percent by the end of 2016. In this forecast, the funds rate path through 2016:Q4 is consistent with market expectations, which indicate that private agents do not expect the federal funds rate to lift appreciably above its effective lower bound until the second quarter of 2015.²

The weak activity forecast is heavily shaped by the model's interpretation of the anticipated path of the federal funds rate inferred from interest rate swaps, which is considerably lower than the model would have anticipated in the absence of data on market expectations. To a considerable extent, in recent quarters, the model accounts for this lower path by attributing to private agents the expectation of relatively adverse financial conditions over the forecast horizon. Over history, these elevated risk premia rationalize the persistently weak recovery along with the lower path of the federal funds rate. In the forecast, the aggregate risk premium

² Observations of the market-expected funds rate path through 11 quarters into the future are provided to the model starting in 2008:Q4.

returns to its early 2012 levels, lowering GDP growth and boosting unemployment above its steady state. The negative impact of expected adverse financial conditions is partly offset by expected unusually accommodative monetary policy in 2014. In addition, repeatedly lower-than-expected labor productivity and surprisingly high inflation have led the model to infer a steady deterioration of aggregate supply conditions since the beginning of 2011. The gradual increase in projected inflation over the forecast horizon is driven by the rebound of wages following negative markup shocks, and by a slow recovery of labor supply.

Since December, data on recent consumption growth and aggregate hours has been substantially more favorable than the model had expected. In particular, the model had anticipated quite weak consumption growth in December and so interprets the unexpected strength of consumption in the last three quarters as signaling greater optimism among consumers about expected financial conditions over the next year. Real GDP growth is thus around a quarter of a percentage point stronger over 2014. However, while this boost to demand substantially lowers the model's forecast for unemployment, it cannot fully account for the surprisingly rapid decline of the unemployment rate in 2014:Q1, almost all of which the model instead attributes to noise in measured unemployment. The model projection for unemployment accordingly remains around its 2013:Q4 value of 7 percent over the forecast horizon.