BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM
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Date: September 9, 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

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This memo describes the economic forecasts for three of the four models that are currently part of the System project on dynamic stochastic general equilibrium (DSGE) models. These are the EDO (Board), PRISM (FRB Philadelphia), and FRBNY models. We first give a summary of the model forecasts and then provide each model's forecasts in greater detail.

Summary of Model Forecasts

The current forecasts for real GDP growth, core PCE inflation, and the federal funds rate, as well as those presented at the June FOMC meeting, are displayed in the table and figures at the end of this summary section. These forecasts were obtained using actual data through 2014Q2 and conditioning assumptions or "nowcasts" for 2014Q3, where the nowcast assumptions for 2014Q3 vary slightly across the models depending on their source (Board staff, FRBNY staff, and Macroadvisers forecasts for EDO, the FRBNY model, and PRISM, respectively). Further, all models assume that federal funds rate expectations are consistent with market expectations at least through 2015Q2.

The story behind all three forecasts is broadly the same: gaps in economic activity have not yet closed, which implies that inflation is projected to remain below mandate consistent levels throughout the forecast horizon. The models also generally agree on the reason why gaps are still open: past shocks to financial conditions –so-called headwinds – have a lasting effect on the economy by continuing to restrain demand and, in particular, investment. Where the models differ is in the projected speed at which gaps will close, with PRISM forecasting a relatively robust growth of the economy while EDO and especially FRBNY foresee a much slower pace of the recovery.

For all models, the forecasts have changed little since June. Generally, the projections have not changed dramatically since the start of the System DSGE project, especially for EDO and FRBNY, given that the economy has largely performed as predicted: the recovery has been sluggish and inflation has been subdued. PRISM has had to mark down their near term growth forecasts, and this is the case in this forecast round as well, but its medium term forecasts remain buoyant. Averaged across all models, output growth forecasts are between 2.2 and 3.2 percent,

rising over the forecast horizon. Average inflation forecasts are slightly higher than they were in June as core inflation in Q2 was a bit higher than expected, but remain below mandate consistent levels throughout the forecast horizon, reaching 2 percent only by the end of 2017.

To varying degrees, EDO, PRISM, and FRBNY all interpret the federal funds rate path implied by market expectations as providing greater accommodation than would be implied by each model's estimated interest rate rule. For both FRBNY and PRISM, interest rates start rising after 2015Q2, when the constraint that models' forecasts match market expectations is removed. The speed of the renormalization varies across models however, consistent with the different assessments regarding the speed of the recovery in economic activity, with the federal funds rate reaching almost 3 percent by the end of 2016 for PRISM, and remaining below 2 percent for FRBNY. EDO constrains federal funds rate expectations through 2017Q2, hence interest rate projections are driven by market expectations for almost the entire forecast horizon for this model. Note that this market-implied path for the federal funds rate lies below the forecasts for both the FRBNY and PRISM models.

Forecasts

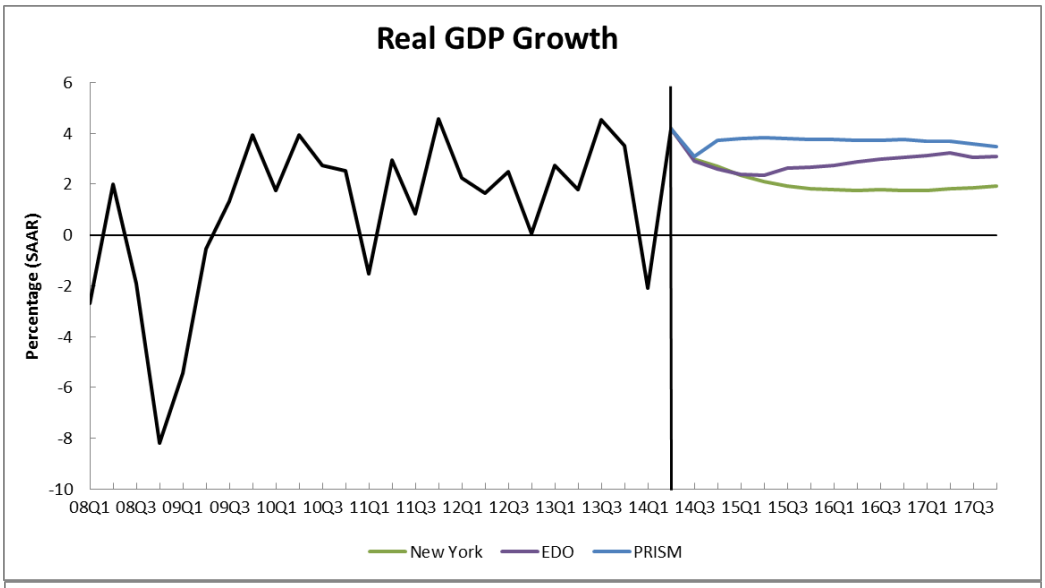
Model	Output Growth (Q4/Q4)						
	2014		2015		2016		2017
	Sep	*Jun*	Sep	*Jun*	Sep	*Jun*	Sep
EDO - Board of Governors	**2.0 (0.2,3.5)**	*1.8 (-0.6,4.1)*	**2.5 (0.2,5.2)**	*2.7 (0.1,4.8)*	**3.1 (1.1,4.8)**	*2.7 (0.8,5.2)*	**3.2 (1.0,5.1)**
New York Fed	**1.9 (1.2,2.4)**	*2.2 (0.9,3.2)*	**2.0 (-1.1,4.5)**	*2.2 (-1.0,4.7)*	**1.7 (-1.5,4.9)**	*1.8 (-1.3,4.9)*	**1.8 (-1.3,5.1)**
PRISM - Philadelphia Fed	**2.2 (1.6,2.9)**	*2.9 (1.4,4.3)*	**3.8 (0.6,7.3)**	*4.2 (0.7,7.7)*	**3.8 (0.5,7.7)**	*3.9 (0.3,7.6)*	**3.7 (-0.5,7.3)**
Median Forecast*	**2.2**	*2.2*	**2.5**	*2.7*	**3.1**	*2.7*	**3.2**

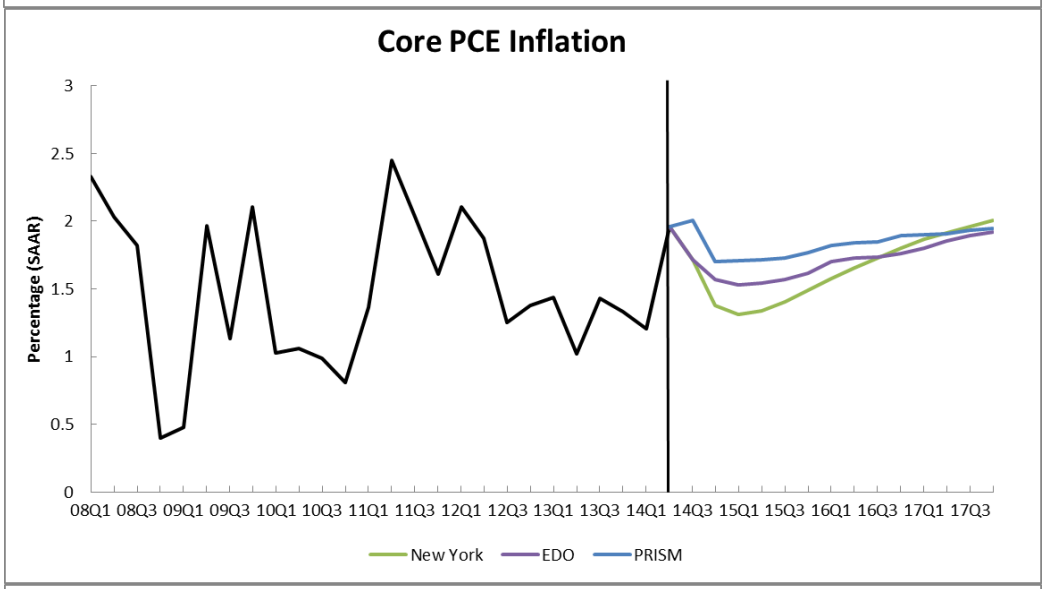
Model	Inflation (Q4/Q4)						
	2014		2015		2016		2017
	Sep	*Jun*	Sep	*Jun*	Sep	*Jun*	Sep
EDO - Board of Governors	**1.6 (1.5,1.7)**	*1.4 (1.2,1.6)*	**1.6 (1.0,2.1)**	*1.4 (0.9,2.0)*	**1.7 (1.0,2.4)**	*1.6 (1.2,2.3)*	**1.8 (1.1,2.6)**
New York Fed	**1.6 (1.4,1.7)**	*1.4 (1.0,1.7)*	**1.4 (0.7,2.0)**	*1.3 (0.6,2.0)*	**1.7 (0.9,2.4)**	*1.7 (0.8,2.4)*	**1.9 (1.1,2.7)**
PRISM - Philadelphia Fed	**1.7 (1.5,2.0)**	*1.4 (0.8,2.0)*	**1.7 (0.3,3.1)**	*1.5 (0.0,3.0)*	**1.9 (0.2,3.6)**	*1.8 (0.1,3.5)*	**1.9 (0.2,3.7)**
Median Forecast*	**1.6**	*1.4*	**1.6**	*1.4*	**1.7**	*1.7*	**1.9**

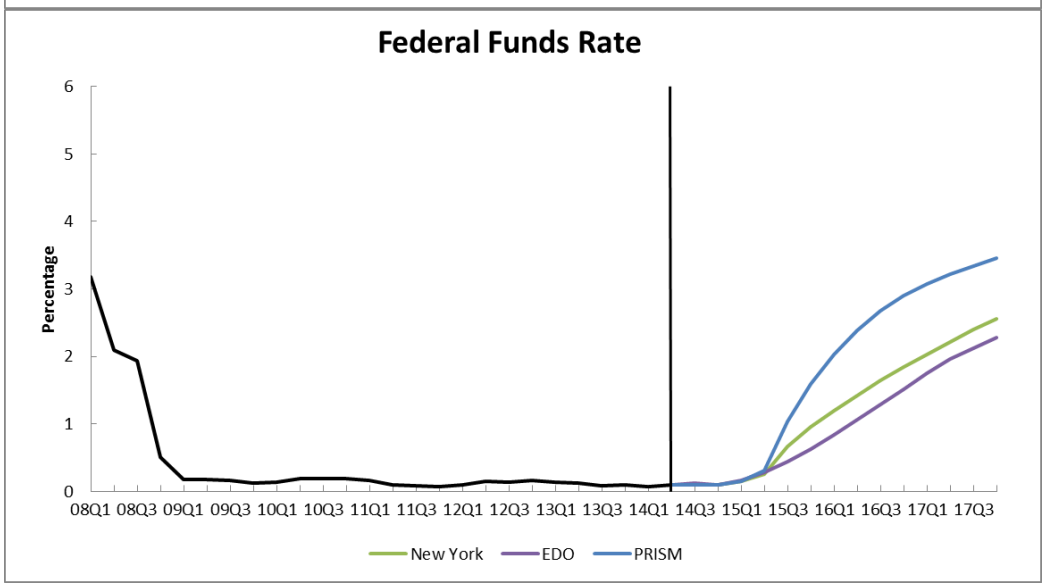
Model	Federal Funds Rate (Q4)						
	2014		2015		2016		2017
	Sep	*Jun*	Sep	*Jun*	Sep	*Jun*	Sep
EDO - Board of Governors	**0.1 (0.0,0.6)**	*0.3 (0.0,0.9)*	**0.7 (0.0,2.4)**	*0.7 (0.0,2.2)*	**1.5 (0.0,3.6)**	*1.5 (0.1,3.4)*	**2.3 (0.4,4.0)**
New York Fed	**0.1 (0.1,0.6)**	*0.1 (0.1,0.8)*	**1.0 (0.3,2.0)**	*0.9 (0.2,2.0)*	**1.8 (0.7,3.1)**	*1.9 (0.7,3.2)*	**2.6 (1.1,4.0)**
PRISM - Philadelphia Fed	**0.1 (-0.4,0.6)**	*0.1 (-0.8,1.0)*	**1.6 (0.0,3.4)**	*1.5 (-0.4,3.6)*	**2.9 (0.2,5.4)**	*2.7 (0.2,5.6)*	**3.4 (0.4,6.2)**
Median Forecast*	**0.1**	*0.1*	**1.0**	*0.9*	**1.8**	*1.9*	**2.6**

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.







Detailed Descriptions of Individual Model Forecasts

The EDO Model

On average, the EDO model projects real GDP growth to remain slightly below its trend of 2.7 percent from 2014Q4 until the end of 2015, and then to increase to slightly above 3 percent in 2016 and 2017. Inflation runs below the Committee's 2 percent objective over the forecast horizon, averaging around 1.6 percent over the next three years. In this forecast, the funds rate path through 2017Q2 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. EDO also provides forecasts for unemployment (not shown here). The model projects the unemployment rate to gradually rise to 6.6 percent by mid-2015, stay at that level through 2016, and gradually decline to 6.2 percent by the end of 2017.

The EDO model forecast conditions on the 2014Q2 data available at the time of the NIPA annual revision and Tealbook forecasts for Q3. The real GDP growth projection for Q3 has been revised up from 2.2 percent to 2.9 percent in 2014Q3, explaining the increase in 2014 GDP forecasts relative to June. As a result of this revision, the medium-term outlook is also slightly more positive compared to June with real GDP growth averaging 3 percent in 2017-2018 and inflation gradually increasing to 1.9 percent in 2017.

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. The model accounts for this lower path by attributing to private agents the expectation of relatively adverse financial conditions over the forecast horizon, especially in the near term. In the forecast, the aggregate risk premium rises 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 expectations of accommodative monetary policy in 2014. The gradual increase in projected inflation over the forecast horizon is driven by the rebound of wages following negative markup shocks and a slow waning of household labor supply shocks, which can be broadly interpreted as capturing labor market frictions.

The FRBNY Model

The FRBNY model forecasts are obtained using data released through 2014Q2, augmented for 2014Q3 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 2014Q3 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 2014Q3 staff projections and OIS rates are those that were available on August 28, 2014.

The FRBNY DSGE forecast for 2014 did not change substantially compared to June: for the short-term the forecast features slightly lower real GDP and higher inflation, where the change in the inflation forecast mainly reflects slightly higher than expected inflation in Q2. However, the forecast is roughly unchanged for the rest of the forecasting horizon. Specifically, relative to June, the GDP growth forecast for 2014 and 2015 (Q4/Q4) decreased to 1.9 and 2.0, respectively, from 2.2 percent, while the forecasts for 2016 and 2017 (Q4/Q4) are at 1.7 percent and 1.8 percent respectively, slightly lower than in June. For inflation, the mean core PCE inflation for 2014 is projected to be 1.6 percent, higher than the 1.4 percent projected in June. Inflation gradually returns closer to the long term objective of 2 percent over the forecast horizon. The point forecasts are 1.4, 1.7, and 1.9 for 2015 through 2017, roughly unchanged relative to the June point forecasts. Uncertainty around real GDP growth and inflation forecasts has diminished for 2014 because the model uses the 2014Q3 nowcast as data, but is broadly unchanged otherwise. For GDP growth, risks are skewed to the downside because of the zero lower bound. The 68 percent bands cover the intervals 1.2 to 2.4 percent in 2014, -1.1 to 4.5 percent in 2015, -1.5 to 4.9 in 2016, and -1.3 to 5.1 in 2017. For inflation, the 68 percent probability bands range from 0.7 to 2.7 percent throughout 2017.

The dynamics behind medium-to-long-term FRBNY DSGE forecasts can be described as follows. The headwinds from the financial crisis are dissipating over time, and their negative effects have started to wane. In fact, spread shocks, which were the main driver of the Great

Recession, provide a positive contribution starting in early 2014. This is consistent with the significant reduction in perceived risks and the ensuing compression in credit spreads observed recently. However, in the past few years the economy has been buffeted by mostly negative shocks, which have slowed down the return to trend. These negative shocks have been partly counteracted by expansionary monetary policy. However, the positive effect of this policy accommodation on the level of output begins to wane from the end of 2014 onward, implying a negative effect on growth. The fact that output is still below trend implies that inflation is below the long term objective.

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. The slow return of the FFR to steady state is mostly driven by the endogenous response of policy to the relatively weak economy, rather than by accommodative policy shocks.

The PRISM Model

The Philadelphia Research Intertemporal Stochastic Model (PRISM) forecast is constructed using data through 2014Q2 that are then supplemented with a 2014Q3 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 futures market data – implied expectations.

PRISM forecasts that growth will accelerate from a 2.2 percent pace in 2014 to an average pace of about 3.7 percent over the next three years. While 2014Q3 real output growth is pinned down at 3.1 percent by the nowcast, the forecast calls for output growth to rise to 3.7 percent in the fourth quarter of 2014, and then peak at a bit over 3.8 percent in 2015Q2. Growth then gradually edges down to about a 3.5 percent pace by the end of 2017. 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 the financial market expectation through 2015Q2 and then rising to 1.6 percent by the end of 2015 and 3.4 percent by the end of 2017.

According to PRISM, an ongoing rebound in the labor market and investment demand will drive above-trend growth over the next 3 years. The model continues to imply a de-trended level of output that is well below its steady state and 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 the largely negative investment and financial shocks that have accumulated over the last 2 years.

The 2014Q3 nowcast for core PCE inflation is 2 percent. The model predicts a slight dip in inflation to 1.7 percent in 2014Q4 and then a gradual increase to 1.9 percent by the end of 2017. The principal factor accounting for slightly 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 begins to rise quickly, jumping about 70 basis points in 2015Q3. By the end of 2017, the funds rate is projected to be at about 3.4 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.