

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

Date: August 31, 2012
To: Federal Open Market Committee
From: Deborah J. Danker
Subject: DSGE Models Update

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

System DSGE Project Forecasts

August 30, 2012

Scott A. Brave, Jeffrey R. Campbell, Jonas D.M. Fisher, Alejandro Justiniano¹

Federal Reserve Bank of Chicago

¹ We thank Hess Chung, Jean-Phillipe Laforte, Michael Kiley, Marco Del Negro, Argia Sbordone, Marc Giannoni, Vasco Curdia, Michael Dotsey, and Keith Sill for their contributions.

This memo describes the economic forecasts 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), FRBNY and Chicago 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 figure at the end of this summary section. These forecasts were obtained using actual data through 2012Q2 along with conditioning assumptions for the future path of the federal funds rate. The latter constraint is imposed similarly across models by anchoring the expected path of the federal funds rate to market expectations. However, the data used and the length of time for which it is a binding constraint on the forecast differ across models. The conditioning assumptions of each model are explained in further detail in the individual summaries below.

The growth projections for 2012 and 2013 (Q4/Q4) are fairly similar across the models, except for PRISM which continues to project a significant strengthening in economic activity. The median forecast across models is for growth of 2.2 percent in 2012, rising slightly to 2.6 percent in 2013. Relative to June, nearly all the models project growth to be somewhat lower in 2012 but then slightly higher in 2013. The median forecast for output growth in 2014 and 2015 is 3.0 percent, but there is significant variability across models. The Chicago model projects growth in economic activity to remain very near its trend through 2015, while growth is expected to be much weaker according to the FRBNY model and stronger by EDO and PRISM.

The weakness in the Chicago and New York projections for output growth continues to be explained in large part by the persistent effects of the financial headwinds that were responsible for both the severity of the recession and its subsequently anemic recovery. EDO's weak activity projections for 2013, on the other hand, are largely shaped by a lower anticipated path for the federal funds rate which is attributed by the model to the expectation of relatively adverse financial conditions over the forecast horizon. In contrast, PRISM predicts a strong rebound of

economic activity driven by the unwinding of labor supply, financial, and marginal efficiency of investment shocks that have to-date restrained the recovery in employment and investment.

The median forecasts for inflation (Q4/Q4) across models are up very slightly from June. In the FRBNY model, the same forces that are the source of the sluggish recovery in output growth also contribute to the subdued outlook for inflation, while negative price mark-up shocks inferred from 2012Q2 data are instead the primary driver of the inflation forecast in the Chicago model. PRISM's inflation outlook remains contained both by the lingering effects of financial shocks and by rising labor supply which puts downward pressure on wages and marginal costs. Similarly, a combination of weak aggregate demand and muted pressure on wages holds the EDO inflation projections below target throughout the forecast horizon.

Despite their differences in the interpretation of forward guidance, nearly all models project a federal funds rate path that is weaker than the one incorporated in June. The FRBNY and PRISM models use market expectations based on futures prices to condition the path of the federal funds rate through mid-2015. The Chicago model uses similar data through the end of 2014, whereas EDO instead incorporates information from interest rate caps assuming a zero term premium over the same time period. As soon as this conditioning is lifted, the model projections imply an immediate increase of the federal funds rate to just less than 1.5 percent by the end of 2015, with the magnitude of the increase depending on the choice of the approximate lift-off date.

Forecast Summary

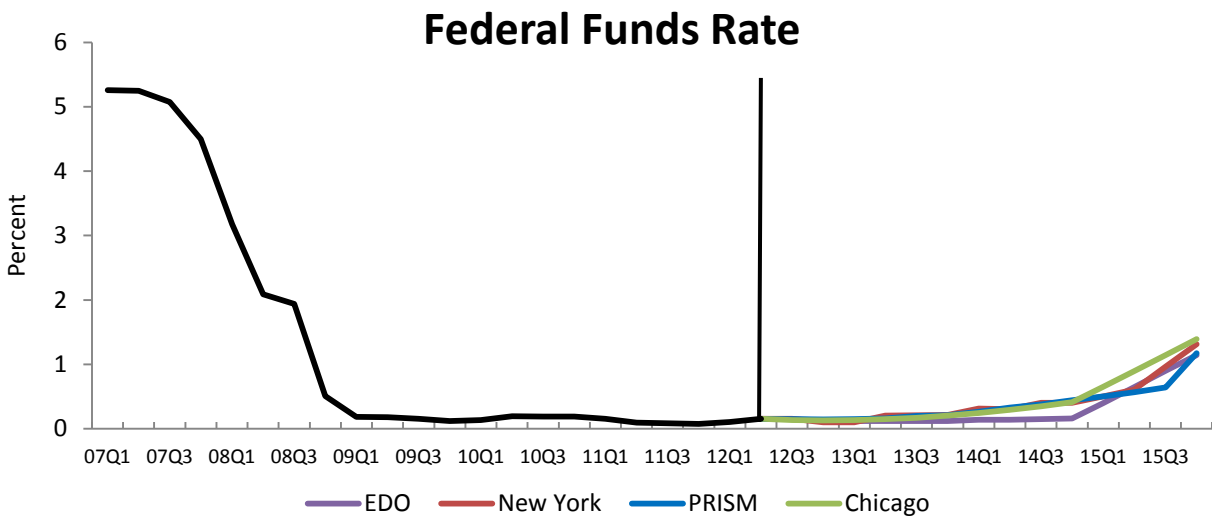
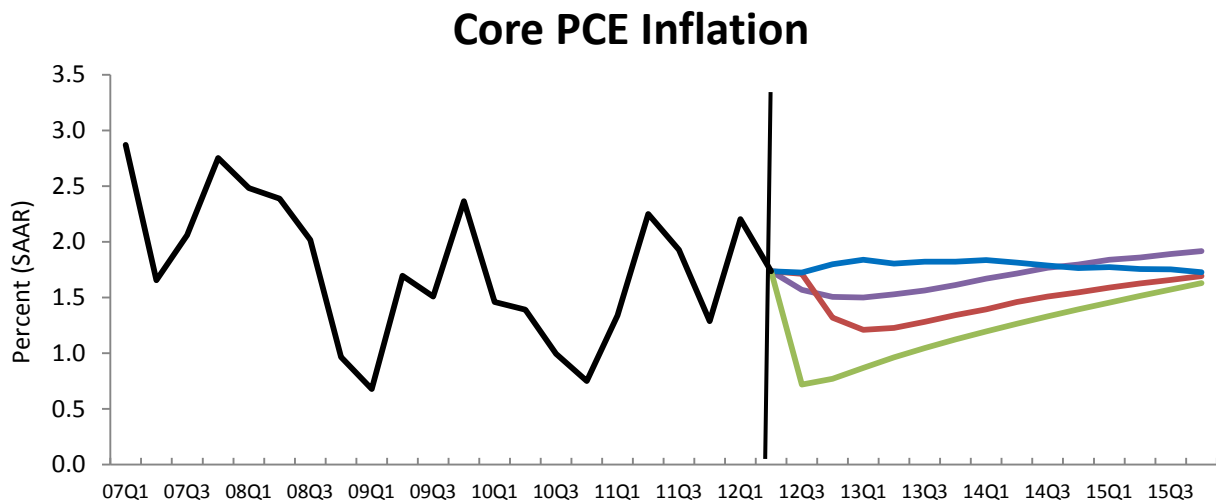
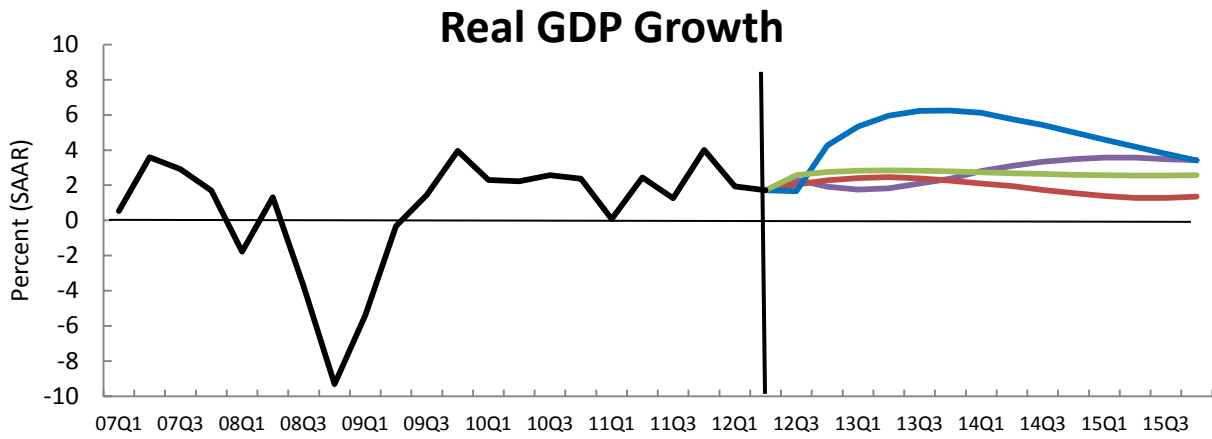
Model	Output Growth (Q4/Q4)						
	2012		2013		2014		2015
	Sept	June	Sept	June	Sept	June	Sept
EDO - Board of Governors	2.1 (-0.3,4.5)	2.3 (0.0,4.7)	2.1 (-0.1,4.3)	2.6 (0.4, 4.6)	3.3 (1.1,5.3)	3.2 (1.1, 5.2)	3.5 (1.5,5.6)
New York Fed	2.0 (1.3,2.5)	2.2 (0.8, 3.2)	2.4 (-0.9,4.6)	2.3 (-1.3,4.8)	1.8 (-1.8,4.6)	1.8 (-1.9,4.7)	1.3 (-2.0,4.4)
PRISM - Philadelphia Fed	2.4 (1.7,3.2)	3.6 (2.0,5.4)	6.1 (2.0,10.4)	5.3 (1.1,9.5)	5.7 (1.2,9.9)	4.5 (0.1,8.6)	4.1 (-0.2,8.6)
Chicago Fed	2.2	2.1	2.8	2.6	2.7	2.5	2.6
Median Forecast*	2.2	2.3	2.6	2.6	3.0	2.9	3.0

Model	Inflation (Q4/Q4)						
	2012		2013		2014		2015
	Sept	June	Sept	June	Sept	June	Sept
EDO - Board of Governors	1.8 (1.5,2.0)	1.7 (1.4, 2.0)	1.6 (0.9,2.2)	1.5 (0.9, 2.2)	1.7 (1.0,2.5)	1.7 (1.0, 2.4)	1.9 (1.1,2.6)
New York Fed	1.7 (1.6,1.9)	1.4 (1.1, 1.7)	1.3 (0.5,1.8)	1.0 (0.2,1.7)	1.5 (0.5,2.1)	1.4 (0.5, 2.1)	1.6 (0.6,2.3)
PRISM - Philadelphia Fed	1.9 (1.6,2.1)	2.0 (1.5, 2.4)	1.8 (0.7,3.0)	1.9 (0.8, 3.1)	1.8 (0.6,3.2)	1.8 (0.6, 3.1)	1.8 (0.4,3.1)
Chicago Fed	1.4	1.3	1.0	1.0	1.3	1.3	1.5
Median Forecast*	1.8	1.6	1.4	1.3	1.6	1.6	1.7

Model	Federal Funds Rate (Q4)						
	2012		2013		2014		2015
	Sept	June	Sept	June	Sept	June	Sept
EDO - Board of Governors	0.2 (0.0,1.0)	0.3 (0.0, 1.0)	0.3 (0.0,1.8)	0.4 (0.0, 1.8)	0.5 (0.0,1.9)	1.0 (0.0, 2.5)	1.3 (0.1,2.8)
New York Fed	0.1 (0.3,0.7)	0.2 (0.3,1.0)	0.2 (0.3,1.3)	0.2 (0.3, 1.4)	0.4 (0.3,1.8)	1.2 (0.3, 2.6)	1.3 (0.3,2.8)
PRISM - Philadelphia Fed	0.1 (-0.5,0.6)	0.2 (-0.7,1.0)	0.2 (-1.5,2.0)	0.2 (-1.8, 2.1)	0.4 (-1.9,3.1)	1.5 (-1.1, 3.8)	1.2 (-1.5,4.3)
Chicago Fed	0.1	0.2	0.2	0.2	0.4	0.4	1.4
Median Forecast*	0.1	0.2	0.2	0.2	0.4	1.1	1.3

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

The EDO model projects real GDP growth below trend on average until the end of 2013 and unemployment around 8 percent until the beginning of 2015. This subdued pace of real activity is accompanied by inflation gradually accelerating from a low of 1.5 percent at the end of 2012 to slightly below 2 percent by the beginning of 2015. Private agents do not expect the federal funds rate to lift appreciably above its effective lower bound until the first quarter of 2015.

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 caps, which is considerably lower than the model would have anticipated given other data.² In part, the model accounts for this lower path by attributing to private agents the expectation of relatively adverse financial conditions over the forecast horizon. The aggregate risk premium remains in the neighborhood of its early 2012 levels, lowering GDP growth and boosting unemployment well above its steady-state. In addition, recent data on labor productivity have led the model to infer a deterioration of aggregate supply conditions since the beginning of 2011.

Given these adverse aggregate supply developments, the path of the funds rate remains only modestly below the level consistent with the model's estimated policy rule, despite the weakness of aggregate demand in the forecast. The additional stimulus from monetary policy boosts growth noticeably through the end of 2012. Inflation is held below target by a combination of weak aggregate demand and muted pressure on wages in the labor market.

The unemployment rate rises slowly through mid-2013, reaching a peak of 8 3/4 percent, before declining to 7 1/2 percent by the end of 2015. The initial rise in unemployment reflects the above-mentioned high risk premiums and adverse supply conditions. By the end of the forecast, however, a substantial portion of the elevated unemployment rate is accounted for by a highly persistent shift in household labor supply. Given the nominal rigidities in the model, labor

² Beginning this round, the anticipated path for the federal funds rate is the modal path consistent with prices on interest rate caps, assuming a zero term premium, through the end of 2014. This trajectory for the federal funds rate is, accordingly, noticeably lower than the expected path based on federal funds futures, used in previous rounds.

supply shocks affect household willingness to work much more strongly than firms' willingness to hire and thus move unemployment much more than other measures of real activity. The model therefore naturally attributes a large share of low-frequency variation in unemployment to this source.

The PRISM Model

The Philadelphia Research Intertemporal Stochastic Model (PRISM) forecast is constructed using data through 2012Q2 that are then supplemented with 2012Q3 projections of output, consumption, investment, wages, and hours worked from the most recent Macroeconomic Advisers forecast, (which forecasts 2012Q3 real GDP growth of about 1.6 percent). In addition, the forecasted path for the federal funds rate is constrained through 2015Q2 using futures market data – implied expectations.

PRISM forecasts a strong rebound from the moderate pace of growth so far this year. The forecast for 2012Q4 real output growth is 4.3 percent, rising to about 6.1 percent in 2013 (Q4/Q4). Output growth then tapers off to 4 percent in 2015. While output growth is projected to be robust, inflation remains contained at a bit below 2 percent through the forecast horizon. The forecast assumes that the funds rate remains in a range of 0 to 25 basis points through the end of 2013, then edging up to 0.44 percent in 2014Q4 and 1.2 percent in 2015Q4.

According to PRISM, the primary factors that accounted for generally below-trend real output growth over the past three quarters were negative shocks to total factor productivity and negative shocks to the efficiency with which investment is turned into capital. The model continues to see the de-trended level of output 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 captured through labor supply shocks, financial shocks, and investment shocks. Looking ahead, the unwinding of the labor supply shocks (rebound in hours worked), financial shocks, and marginal efficiency of investment shocks (rebound in investment) are key factors in accounting for strong output growth over the next three years. Inflation, however, remains contained both because the increase in labor supply puts downward pressure on wages and marginal costs, and because of lingering effects of financial shocks. Going forward, the model predicts core PCE

inflation will edge up to about 1.8 percent in 2012Q4 and then remain near that level through the end of 2015.

The forecast for PRISM obtained without using federal funds rate expectations as conditioning information continues to project a much stronger path for monetary policy over the next 3 years. With output projected to grow at an above-trend pace and inflation running only slightly below the target rate, the unconditional PRISM forecast has the funds rate rising immediately and then reaching about 3.2 percent by the end of 2015.

The FRBNY Model

The FRBNY model forecast is obtained using data released through 2012Q2, augmented for 2012Q3 with the FRBNY staff forecast 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 2012Q3 observations up to August 20. The expected future federal funds rates are constrained to equal market expectations for the federal funds rate, as measured by the OIS rates, through 2015Q2.

Output growth in 2012Q2 and 2012Q3 (as projected by FRBNY staff) is in line with the June DSGE model forecasts, while the FRBNY staff's projection for 2012Q3 core PCE inflation is stronger than the June DSGE model forecast. As a consequence, the projections for output are similar to those presented in June, while those for inflation are more sanguine through mid-2013, and similar afterwards. In essence, the model still projects a lackluster recovery in economic activity, with output growth in the neighborhood of 2 percent throughout the forecast horizon, and core PCE inflation below the FOMC long-run goal of 2 percent. Output growth forecasts for 2012, 2013, and 2014 (Q4/Q4) are 2.0, 2.4, and 1.8 percent, respectively, compared to 2.2, 2.3, and 1.8 percent, respectively, reported in June. Core PCE inflation projections for 2012, 2013 and 2014 (Q4/Q4) are 1.7, 1.3, and 1.5 percent, respectively, compared to 1.4, 1.0, and 1.4 percent, respectively, in June.

There is significant uncertainty around real GDP forecasts, with 68 percent bands covering the interval 1.3 to 2.5 percent in 2012 (Q4/Q4), and -0.9 to 4.6 percent in 2013 (Q4/Q4). The

forecast distribution for inflation moved up relative to June, but the 68 percent probability bands are within the 0.5-2.1 percent interval throughout 2014.

The FRBNY forecast is driven by two main factors. On the one hand, the headwinds from the financial crisis, as captured by the effect of both spread and MEI (marginal efficiency of investment) shocks, result in a subdued recovery, low real marginal costs, and consequently low inflation. The impact of these shocks on the recovery is long-lasting and starts to wane only in mid-2013. On the other hand, accommodative monetary policy, and particularly the forward-looking language, plays an important role in counteracting the financial headwinds, and lifts up output and inflation. Monetary policy plays a stronger role in the current forecast than in June, as we now extend by four quarters the horizon for which we constrain FFR model expectations to coincide with market expectations. We do such extension in order to incorporate in the forecasts the possibility of further policy accommodation as captured by market expectations. The impact of policy on the *level* of output starts to wane by the end of 2012, which implies that the effect of policy on *growth* is actually negative after that. This largely explains why growth is still below trend by the end of the forecast horizon.

The model views the federal funds rate at the zero lower bound as mostly driven by the endogenous response of policy to the weak economy. In fact, by the end of 2012 the historical rule would imply a rate that is slightly lower than 25bp. However, by the end of the forecast horizon the policy accommodation provided by the forward-looking language becomes noticeable, implying a deviation from the historical rule of about one percentage point.

The Chicago model

The Chicago model forecast incorporates data through 2012Q2. We use forward guidance shocks to help shape the model's expected federal funds rates through 2014 based on their implied values from current futures markets prices. The model also includes a slowly drifting inflation anchor (currently 2.5 percent) which dominates changes in long-run expected inflation and is disciplined by equating the 10-year average of model-based expected consumer price inflation with 10-year-ahead CPI forecasts from the Survey of Professional Forecasters (SPF).

The Chicago forecasts for both real GDP growth and inflation have not changed substantially from June. Real GDP growth in 2012 Q4/Q4 is projected to be 2.3 percent, up 0.2 percentage points from June. The economy is projected to grow near potential (2.7 percent in our model) throughout the remainder of the forecast horizon, an upward revision of about 0.2 percentage points from June. The forecasted path for Q4/Q4 core PCE inflation remains in the range of 1.0 to 1.5 percent throughout the forecast horizon.

Adverse demand shocks, in particular a spread shock embodying movements in the external finance premium beyond what is warranted by firms' balance sheets, largely explain the near-term weakness in the recovery of economic activity. At longer horizons, adverse technology shocks play a similar role. For inflation, recent negative price mark-up shocks account for the sharp decline in inflation projected for the second half of 2012, whereas the subsequently modest increase can be traced back to a moderately higher Q2 SPF forecast for 10-year CPI inflation.

By the end of 2014, we project the federal funds rate to be 0.4 percent, unchanged from June. The systematic component of our Taylor rule suggests a marginally higher forecast path for the funds rate than in June. Offsetting this, however, is our use of market expectations to shape the model's path for the expected federal funds rate. These expectations hold the funds rate below 0.25 percent through late 2014. After 2014, the funds rate rises on average 25 bps per quarter, ending 2015 at 1.4 percent.