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To: Federal Open Market Committee
From: Deborah J. Danker
Subject: DSGE Models Update

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

System DSGE Project Forecasts

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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.

Forecasts Summary

The current forecasts for real GDP growth, core PCE inflation, and the federal funds rate, as well as those presented at the January FOMC meeting, are displayed in the table and figure at the end of this summary section. These forecasts are constructed using data through 2011Q4 as well as estimates of 2012Q1 data. The projections are also conditioned on the anticipation that the federal funds rate will remain exceptionally low through at least 2013. This is done in a variety of ways. The PRISM forecast constrains the funds rate to be near zero through the second quarter of 2014, while the New York forecast constrains the expectations of future funds rates to follow the OIS-based expected future funds rate over the same period. The EDO forecasts are conditioned on a funds rate path that matches an estimate of the path expected by market participants through 2014Q1. Thus, there are slight differences among the forecasts in their view of forward guidance. Importantly, all the models constrain the projected funds rate paths to be noticeably weaker than the one incorporated in the January forecasts.

The growth projections for 2012 (Q4/Q4) are quite different across the four models, although they are not that different from those presented in January. Both the PRISM and Chicago models anticipate stronger than trend growth this year, with PRISM showing a significant strengthening in economic activity. In PRISM, that strength is due to the confluence of a number of factors. The model views the current level of economic activity as well below its steady state and part of the projected growth is due to the economy's return to steady state. Those dynamics, along with the unwinding of labor supply shocks that previously kept employment weak and the attenuation of marginal efficiency of investment shocks that were restraining investment, contribute to a robust recovery.

In contrast both the EDO and New York models anticipate below trend economic activity, and this view is influenced in large part by the continued persistent effects of the financial headwinds that were responsible for both the severity of the recession and the weakness of the

current recovery. Additionally, weak readings on total factor productivity contribute to the near-term economic weakness in the EDO forecast.

In 2013 and 2014, the models continue to show substantial differences in the projected pace of recovery. Both the New York and EDO models do not see any significant rebound in economic activity in 2013, though EDO does see the pace of economic activity picking up in 2014. The New York projection is for a weak economy throughout the forecast horizon. The Chicago and PRISM models see a stronger recovery as the economy returns to trend, but only the PRISM forecast can be associated with a relatively robust recovery. However, the New York, EDO, and PRISM models share a common feature in that monetary policy exerts a negative impact on projected output growth in the latter part of the forecast horizon.

While the point forecasts do not have core PCE inflation exceeding the Committee's target over the forecast horizon, the projections are somewhat higher than they were in January. The rise in inflation during 2011 is in part a contributor to the higher inflation projections, but accommodative future monetary policy also leads to upward pressure on inflation in the models. To varying degrees, this impetus is offset by other model factors. In the PRISM and Chicago models, past weakness in aggregate demand brought about by shocks to agents' discount factors implies that marginal cost pressures will be rather tepid, resulting in significant downward pressure on the projected rate of inflation. The weakness in the inflation forecast in the EDO and the New York models is also in part due to weaker-than-trend economic activity. The New York model also attributes the recent rise in inflation to transitory movements in the markup and thus projects a path for inflation that is below the Committee's long-run target. The fact that all inflation forecasts are below the estimated target indicates that the current slack in the economy is projected to persist.

In terms of interest rates, all four models project extremely low interest rates over the forecast horizon and rates significantly lower than anticipated in January. The change in view results from the greater degree of forward guidance embedded in the forecasts. By construction none of the models project any significant policy tightening until the latter half of 2014 when the FOMC is expected to begin conducting policy according to each model's estimated policy rule.

Forecast Summary

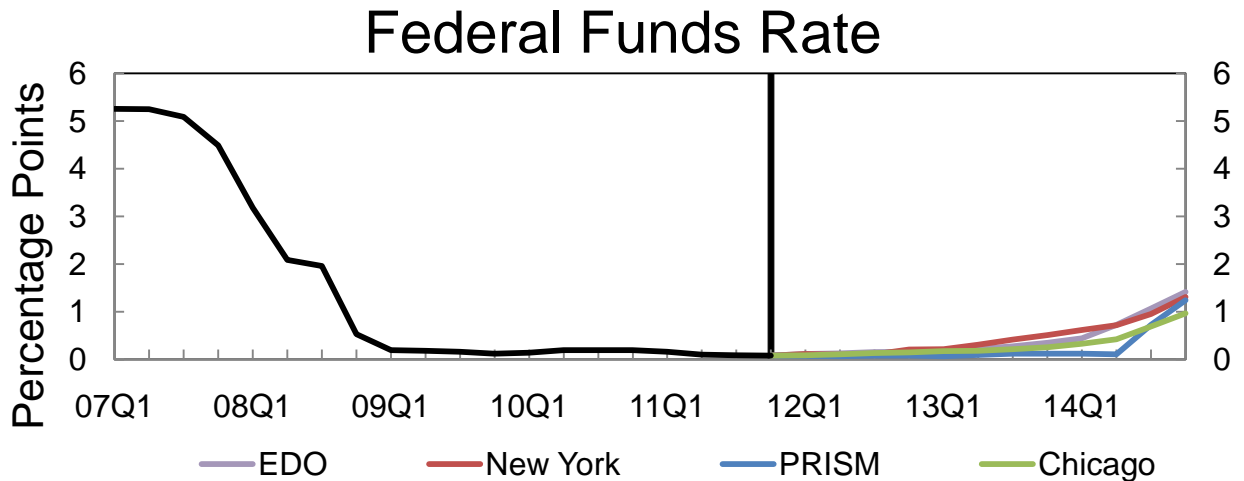
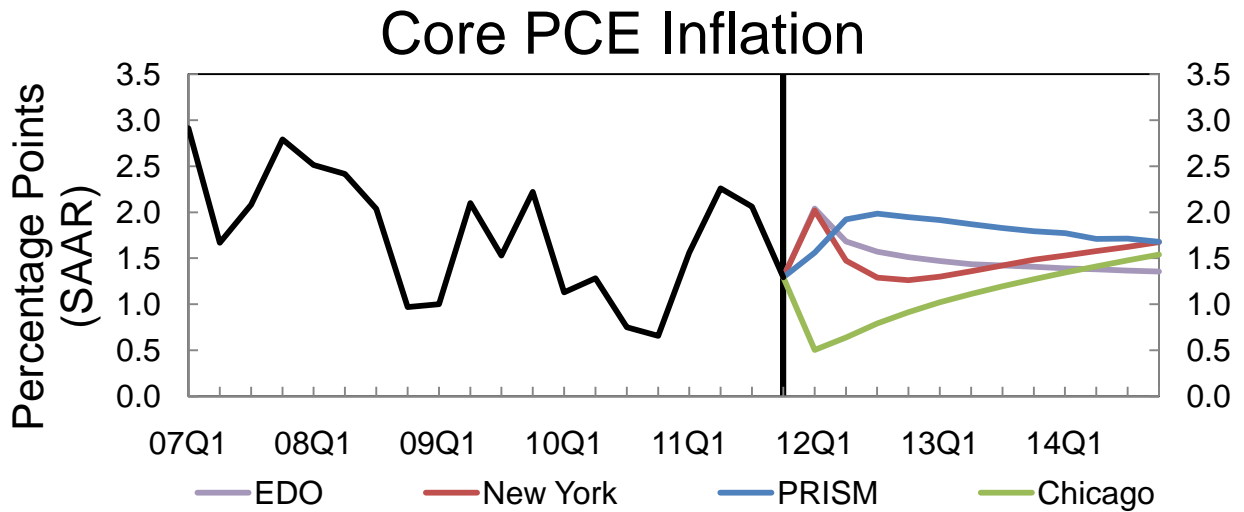
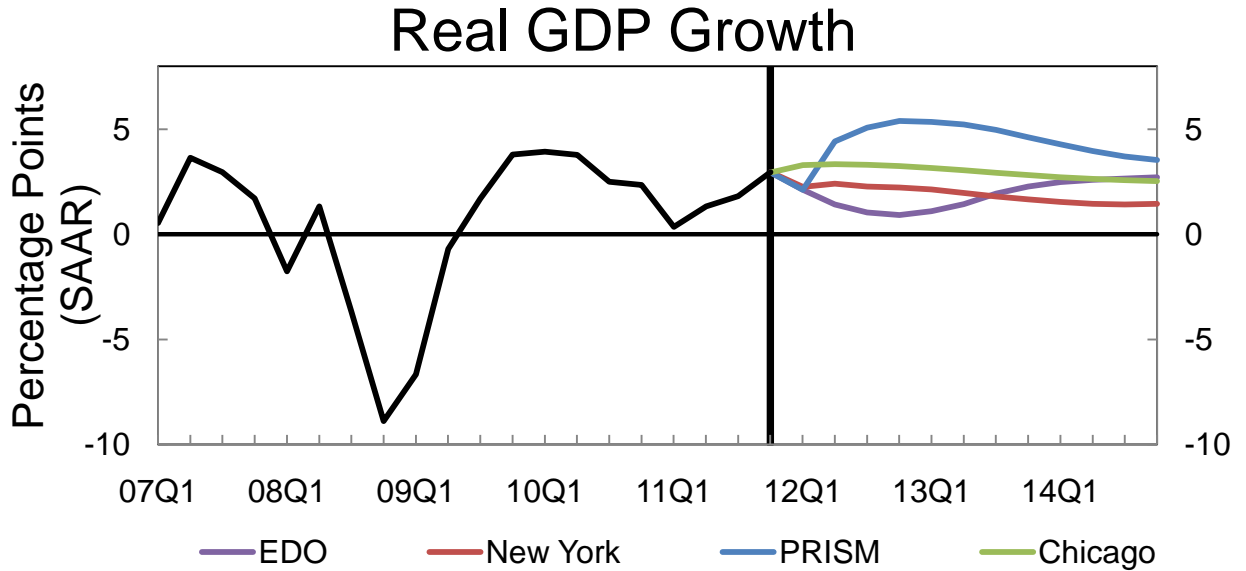
Model	Output Growth (Q4/Q4)					
	2012		2013		2014	
	Apr	Jan	Apr	Jan	Apr	Jan
EDO - Board of Governors	1.4 (-1.0,3.8)	1.6 (-1.5,4.1)	1.7 (0.0,3.4)	2.3 (0.5,4.0)	2.6 (1.0,4.3)	3.0 (1.3,4.7)
New York Fed	2.3 (0.0,3.8)	3.2 (0.2,5.3)	1.9 (-1.7,4.6)	2.3 (-1.4,5.1)	1.4 (-1.9,4.6)	1.9 (-1.4,5.2)
PRISM - Philadelphia Fed	5.2 (1.6,8.8)	5.0 (1.6,8.7)	4.9 (0.8,9.0)	4.8 (0.7,8.8)	3.7 (-0.5,7.8)	4.1 (0.1,8.4)
Chicago Fed	3.4 (,,)	2.8 (,,)	3.1 (,,)	2.0 (,,)	2.7 (,,)	1.9 (,,)
Median Forecast*	2.8	3.0	2.5	2.3	2.7	2.5

Model	Inflation (Q4/Q4)					
	2012		2013		2014	
	Apr	Jan	Apr	Jan	Apr	Jan
EDO - Board of Governors	1.7 (1.3,2.2)	1.1 (0.4,1.7)	1.4 (0.8,2.1)	1.2 (0.5,1.8)	1.4 (0.7,2.0)	1.3 (0.6,1.9)
New York Fed	1.5 (1.0,1.9)	0.7 (0.1,1.3)	1.4 (0.5,2.0)	1.2 (0.3,1.9)	1.6 (0.6,2.3)	1.6 (0.6,2.3)
PRISM - Philadelphia Fed	2.0 (0.7,3.2)	1.1 (-0.1,2.4)	1.8 (0.2,3.4)	1.2 (-0.2,2.8)	1.7 (0.1,3.4)	1.3 (-0.3,3.0)
Chicago Fed	0.7 (,,)	0.8 (,,)	1.2 (,,)	0.9 (,,)	1.4 (,,)	0.9 (,,)
Median Forecast*	1.6	1.0	1.4	1.2	1.5	1.3

Model	Federal Funds Rate (Q4)					
	2012		2013		2014	
	Apr	Jan	Apr	Jan	Apr	Jan
EDO - Board of Governors	0.2 (0.0,1.5)	0.4 (0.0,1.8)	0.3 (0.0,2.1)	0.6 (0.0,2.1)	1.4 (0.4,3.1)	1.8 (0.4,3.3)
New York Fed	0.2 (0.3,1.2)	0.2 (0.3,1.3)	0.5 (0.3,1.7)	0.8 (0.3,2.2)	1.3 (0.3,2.7)	1.9 (0.5,3.4)
PRISM - Philadelphia Fed	0.1 (-1.2,1.2)	0.0 (-1.4,1.5)	0.1 (-2.0,2.2)	0.8 (-1.5,2.9)	1.2 (-1.5,3.6)	1.7 (-1.0,4.1)
Chicago Fed	0.1 (,,)	0.2 (,,)	0.3 (,,)	1.0 (,,)	1.0 (,,)	2.4 (,,)
Median Forecast*	0.1	0.2	0.3	0.8	1.3	1.9

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

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



Detailed Descriptions of Individual Model Forecasts

The EDO Model

The EDO model projects that real GDP will advance at a pace modestly below trend going forward—a bit less than 2 percent on average over 2012-2014. This pace in real activity is accompanied by inflation gradually falling from its current level to about 1.4 percent, substantially below the target of 2 percent, reflecting the labor market slack apparent in the shortfall of output relative to its long-run trend estimated by EDO. The federal funds rate does not lift appreciably above its effective lower bound until early 2014; the path of the policy rate holds in expectation in the projection of the remaining variables.

As in previous forecasts, the model suggests that recovery from the adverse shocks to financial conditions in 2008 and early 2009, coupled with extensive monetary stimulus, should have supported a robust expansion since 2009, continuing through much of the forecast period. However, in reaction to labor market data over the last several quarters, the model projects relatively weak trend labor productivity and a low growth rate for trend hours. Moreover, the expansionary impact of monetary stimulus is highly front-loaded, as households and firms will have adjusted their behavior in anticipation of the funds rate path shown in the forecast. Consequently, as the economy converges back to its long-run growth path, the unwinding of these policy shocks holds down growth over the forecast period.

Since January, data on aggregate hours have been revised up to a greater extent than output, leading the model to infer a worsening of aggregate supply conditions over recent history, especially in the first quarter of 2012. These revisions to potential output contribute to a weaker pace in real activity going forward relative to January. Given these adverse supply developments, the expected path of the funds rate, little changed since January, appears more accommodative, albeit not sufficiently so as to completely offset weaker supply conditions. The downward revisions to trend labor productivity and the residual effects of large mark-ups at the end of last year and the beginning of this year keep inflation from falling too rapidly over the projection period.

The FRBNY Model

The FRBNY model forecast is obtained using data released through 2011Q4, augmented for 2012Q1 with observations on the federal funds rate, the spread between Baa corporate bonds and 10-year Treasury yields, and the NY Fed staff forecast for real GDP growth, core PCE inflation and growth in total hours. Furthermore, the expected future funds rates are constrained to equal the OIS-based expected future funds rate through 2014Q2.

The model still projects a lackluster recovery in economic activity, with output growth in the neighborhood of 2 percent throughout the forecast horizon. These projections are broadly similar to those presented in January, but more pessimistic, partly because the model expected higher growth in 2012Q1 than currently projected by the NY Fed staff. Specifically, output growth forecasts for 2012, 2013, and 2014 (Q4/Q4) are 2.3, 1.9, and 1.4 percent, respectively, compared to 3.2, 2.3, and 1.9 percent, respectively, in January. The model was surprised by the strength of inflation in 2012Q1. Such strength is viewed as partly transitory, however, as it contributes to pushing up inflation mainly in 2012 and to a lesser extent in 2013, compared to the January forecast. Inflation remains subdued throughout the forecast horizon: projections for 2012, 2013, and 2014 (Q4/Q4) are 1.5, 1.4, and 1.6 percent, respectively, compared to 0.7, 1.2, and 1.6 percent, respectively, in January.

There is significant uncertainty around real GDP forecasts, with 68 percent bands covering the interval 0.0 to 3.8 percent in 2012 (Q4/Q4), and -1.7 to 4.6 percent in 2013 (Q4/Q4). The forecast distribution for inflation moved up relative to January: the 68 percent probability bands for 2012 are still within the 1-2 percent interval, implying that the model places high probability on inflation realizations below the implicit FOMC target, but the upper band is at 2 percent or above in 2013 and 2014 (Q4/Q4).

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 2014, toward the end of the forecast horizon. 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. 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, which explains why growth is still below trend by the end of 2014. The model attributes the pickup in core inflation in 2011, and to some extent also in recent months, to mark-up shocks, which capture temporary swings in inflation, such as those due to oil price fluctuations.

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. Policy shocks currently keep the federal funds rate about 50 basis points lower than implied by the historical rule. Moreover the near-zero policy rate through the end of 2013 is seen by the model as 50 to 75 basis points more accommodative than what would be implied by the historical rule.

The PRISM Model

The Philadelphia Research Intertemporal Stochastic Model (PRISM) forecast is constructed using data through 2011Q4 that are then supplemented with 2012Q1 projections of output, consumption, investment, wages, and hours worked from the most recent Macroeconomic Advisors forecast (which forecasts 2012Q4 real GDP growth of about 2.2 percent).

PRISM continues to forecast a fairly strong recovery with real GDP growth at about 5 percent (Q4/Q4) in 2012 and 2013, falling to about 3.7 percent in 2014. While output growth is projected to be fairly robust, inflation remains contained at about 2 percent through the forecast horizon. The forecast assumes that the funds rate remains in a range of 0 to 25 basis points through mid-2014. By the end of 2014, the funds rate is projected to increase to about 1.24 percent.

According to PRISM, the primary factors that accounted for generally below-trend real output growth over the past four 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. Looking ahead, the unwinding of the labor supply shocks (rebound in hours worked) and the marginal efficiency of investment shocks (rebound in investment) are key factors in accounting for strong output growth over the next three years.

The rebound in aggregate hours puts upward pressure on inflation through rising wages and higher marginal costs. However, this is largely offset by the unwinding of discount factor shocks. In PRISM, discount factor shocks shift preferences toward future consumption, increase saving, and boost investment. They thus work to keep inflation in check through capital deepening and lower marginal costs. As these shocks unwind, the downward pull on inflation eases but nonetheless remains significant over the next three years. Going forward, the model predicts core PCE inflation will peak at about 2 percent in 2012Q3 and then decline gradually to about 1.7 percent by the end of 2014. The model accounts for movements in core inflation over the last four quarters largely by a sequence of temporary factors that have little persistence.

The unconditional forecast for PRISM (the forecast that does not use federal funds rate expectations as conditioning information) projects a much stronger path for monetary policy over the next three years. With output projected to grow at an above-trend pace and inflation running above the target rate, the unconditional PRISM forecast has the funds rate rising immediately and then reaching about 3.75 percent by the end of 2014.

The Chicago model

In the Chicago model, there have been significant changes to two model parameters as compared to their values estimated on a pre-crisis sample. This was done so that the model better reflected our views on the nature of the current policy environment. These changes make the interest rate rule more sensitive to the output gap and discount rate shocks die out more slowly. Specifically, the discount rate shock now has a half life of three and a half years as compared to its estimated half life of four quarters. The latter change is designed to capture the idea that the deleveraging process now is slower than before the crisis.

Our parameter estimates are based on the pre-crisis sample and we do not think this is informative about the current environment when it comes to deleveraging. Consequently we

adjusted the persistence parameter based on our current views on what its magnitude is. It was hoped that our financial accelerator would help us avoid making such a change, but it does not.

The new policy rule is based on an output gap construct that is discussed in our recent Brookings paper and reflects what President Evans views as the best description of policy within the context of this class of models. We have also tripled the coefficient on the gap to reflect our judgment of the Committee's current behavior as opposed to its estimated behavior before the crisis. In addition, forward guidance is incorporated using a factor structure that permits correlation between the forward guidance shocks going out ten quarters. The factor loadings are estimated over the post-crisis period. The methodology is described in more detail in our Brookings paper.