Identifying the Sources of the Unexpectedly Weak Economic Recovery Using the FRB/US Model

Hess Chung and Eric Engen
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I. Introduction

The economic recovery has proved to be significantly slower than the staff anticipated three years ago. At the time of the January 2010 Tealbook forecast, real GDP appeared to have expanded briskly during the second half of 2009, and the staff projected that output would continue expanding at a pace well above trend for the next several years. Specifically, as shown in the top panel of Figure 1, the staff projected in January 2010 that real GDP would increase about 3½ percent in 2010 and then rise at an annual rate of around 4½ percent in 2011 and 2012. In contrast, real GDP growth has averaged only about 2 percent over the past three years. Moreover, the BEA subsequently revised down its historical estimates of real GDP in prior years, revealing that the 2008-2009 recession was deeper and the initial recovery slower than originally thought. As a result, the current level of real GDP is now estimated to be more than $1 trillion—or 8¼ percent—lower than the staff anticipated it would be back in early 2010 (middle panel). Meanwhile, the unemployment rate is currently about 2 percentage points higher (bottom panel).[1]

Because the staff's projection is produced judgmentally and does not rely on any single model, parsing the precise sources of these revisions is not possible. In this memo, however, we use the staff's FRB/US model to provide an accounting of the factors driving the unexpected weakness in the pace of the recovery. Subject to the usual caveats that apply to any model-based analysis, the main lessons from this analysis are:

- The largest contributor to the surprisingly slow recovery has been the lower-than-expected path for potential output now estimated by the staff.

- Foreign economic activity has provided an unanticipated drag on real U.S. GDP growth, particularly following the intensification of the fiscal and financial problems in Europe.

- U.S. fiscal policy has been tighter than anticipated during the recovery, reflecting unexpected cuts in both state and local government purchases and federal defense spending.

- The FRB/US model sees unexpected weakness in spending for housing construction as weighing on real GDP growth throughout the recovery.

- The upward surprises to the staff's unemployment rate projection relative to the January 2010 forecast include sizeable contributions from the staff's current estimate of a higher

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[1] The analysis in this memo treats the staff's December Tealbook estimates for the unemployment rate and real GDP in the fourth quarter of 2012 as data since they incorporate a substantial portion of the underlying source information for the quarter.

natural rate of unemployment and, particularly during last year, from unexpectedly weak foreign activity.

II. Methodology

Large-scale macroeconomic models provide a convenient framework for identifying the sources of the staff's forecast errors over the past three years, because they allow us to view the movements in the economy over time as the dynamic effects of a finite number of fundamental shocks. While the results of such an exercise are inherently model-specific, as different models will provide different identifications of the historical shocks to the economy and their effects, the use of a model enables us to account for forecast errors in both output and unemployment in a dynamic general-equilibrium system that provides a consistent and unified economic interpretation of historical events.

In this memo, we use the FRB/US model for this task. Specifically, for the staff's judgmental projections in both January 2010 and December 2012, we select paths for various factors—treated as exogenous in the FRB/US model—that the model uses to explain the evolution of the economy such that the resulting model simulations match a large number of key variables in the staff projections, such as output, unemployment, and inflation.[2] These exogenous factors include, for example, certain determinants of aggregate supply, such as trend multi-factor productivity and the natural rate of unemployment, along with unexplained movements in risk premiums, consumer spending, and business investment. Importantly, among the variables matched in this exercise are the staff's estimates of the determinants of potential output and the natural rate of unemployment. Accordingly, our calculations take into account the ways the staff has revised several important conditioning assumptions underlying the Tealbook forecast over the past three years. Nevertheless, the resulting FRB/US decomposition is not necessarily the same as what the staff might produce if it were to undertake a similar exercise using the various models and procedures that inform the judgmental Tealbook projection, given that FRB/US forecasts are only one of the inputs into this process.

Figure 2 provides some perspective on the extent to which the staff has altered its supply-side assumptions. As indicated in the upper-left panel, the staff's current estimate of the path of potential output between 2006 and 2012 is appreciably lower than that estimated and projected in January 2010. Some of these downward adjustments to potential GDP were made in response to the July 2010 annual revisions to the national accounts, which included downward revisions to the level of actual output in previous years. The staff further trimmed its historical estimates of potential GDP noticeably over the course of 2012 as the unemployment rate declined more rapidly than expected at that time in the face of only tepid growth in overall output.[3] Cumulatively, these revisions have left the level of potential output at the end of 2012 around 6¼ percent below what was anticipated in the January 2010 forecast; as shown in the upper-right

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[2] As with any model-based analysis, these decompositions are, in principle, dependent on specific settings of the model, including the choice of a monetary policy rule. In the simulations in this memo, we use the outcome-based rule to characterize monetary policy. The decomposition results reported here are not sensitive to reasonable alternative specifications of monetary policy, such as using an inertial version of the Taylor (1999) rule in place of the outcome-based rule.

[3] At the same time, we also took the view that some of the surprising decline in the unemployment rate reflected a reversal of the surprising *increase* that took place in 2010.

panel, the accompanying downward revision to the rate of potential output growth from 2010 through 2012 was about 1 percentage point per year on average. Finally, as shown in the middle-left panel, the staff boosted its estimate of the natural rate of unemployment 0.8 percentage point from 5.2 percent to 6.0 percent starting in 2009.

Figure 2 also provides information on foreign economic activity and U.S. fiscal policy. As shown in the middle-right panel, although foreign GDP growth was higher than expected in 2009 and 2010, it has been weaker than anticipated over the past two years as the fiscal and financial problems in Europe intensified. In addition, U.S. fiscal policy has turned out to be tighter than anticipated in the January 2010 projection. As indicated in the lower-left panel, real federal government purchases in 2011 and 2012 were less than initially expected, reflecting reductions in defense spending. Real state and local government purchases—displayed in the bottom-right panel—also have been lower than expected as state and local payrolls and real construction expenditures have been cut back beyond what would normally be associated with weaker GDP growth.

As previously mentioned, in the context of FRB/US, such revisions to supply-side conditions, foreign activity, and fiscal policy reflect changes in underlying exogenous factors, such as multi-factor productivity, which, in turn, prompt endogenous shifts in aggregate income, household spending, and business investment. In the model's accounting presented in the next section, such endogenous shifts in aggregate spending and output are allocated to these fundamental factors. In general, however, the model's equations do not explain all movements in spending endogenously. The movements in real GDP caused by such "residual" shifts in consumption, residential investment, or business investment are attributed to these categories of aggregate demand.

In some cases, these residuals can be associated with specific events or mechanisms which operate outside the scope of the model—for example, the Japanese earthquake in 2011. In general, however, such a correspondence with a specific event cannot be identified. For similar reasons, any errors in the model's characterization of the dynamics of the economy over the last few years, such as a failure to control for a possible reduced interest rate sensitivity of consumption and investment in the wake of the financial crisis, will be misidentified as an unexplained shock to spending instead of being attributed to financial factors.[4] Furthermore, the calculations reported in this memo implicitly assume that the staff's early-2010 characterization of the transmission mechanisms propagating shocks to productivity or monetary policy throughout the economy are basically the same as those embedded in the *current* FRB/US model structure. In actuality, since 2010 the staff has modestly attenuated its assessments of the influence of monetary policy on real activity.

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[4] To the degree that the fallout from the financial crisis and the recession has altered the transmission channels of monetary policy and other propagation mechanisms, we would expect to see a consistent pattern of shocks in the affected sectors. While some evidence supporting such disruptions can be adduced, to date evidence for a break in the FRB/US equations remains equivocal outside the housing sector.

III. FRB/US Model Results

Table 1 shows the FRB/US decomposition of the staff's forecast errors since the January 2010 Tealbook projection. The top panel of the table presents this decomposition for the level of real GDP, the middle panel for the rate of real GDP growth, and the bottom panel for the unemployment rate. In these decompositions, each column represents the contribution to the total forecast error ascribed to each category of shocks at a given point in time, where the contribution is the cumulative effect of all shocks of that type up to that date, including shocks that occurred prior to 2010. At a given date, the total forecast revision shown in the last column of each table is the sum of the deviations attributable to each category of shocks.[5]

Potential Output

As indicated in the first column of the top panel, the contribution of shocks associated with the downward revision to the staff's estimate of the level of potential output accounts for 6.7 percentage points of the total 8.3 percent downward surprise in the level of actual GDP by the end of 2012. This contribution is roughly in line with the 6¼ percent reduction in the estimated level of potential output at the end of 2012 (illustrated in Figure 2).[6]

As shown in the middle panel, because a portion of the revisions to potential GDP were for years prior to 2010, the effect of the lower path for potential output on the four-quarter growth rate of real GDP during the recovery is less pronounced than it is for the level of GDP. Although contributions of revisions to potential slightly exceed the forecast error in real GDP growth in 2010, the downward revisions to potential account for only 0.9 percentage points of the 2.8 percent forecast error for real GDP growth in 2011, and only 0.8 percentage points of the equivalent forecast error for real GDP growth in 2012. Nevertheless, for the three years taken together, the staff's revisions to potential account for almost half of the average forecast error for the growth rate of real GDP.

Finally, as shown in the lower panel, adverse aggregate supply conditions (indicated in the potential output column) raised unemployment over the last three years by 0.8 percentage point. Essentially all of this effect is attributable to the 0.8 percentage point increase in the staff's estimate of the natural rate of unemployment over this period, which was shown in Figure 2.

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[5] In the top and middle panels of Table 1, the deviations from the baseline level and the deviations in growth rates are both calculated as simple percentages. As revisions to both the growth rates and the levels are sizeable, the difference between the revised levels in the two years may differ somewhat from the revised growth rate over that period, with most of the discrepancy arising from the large contribution from potential output. Moreover, downward revisions to the level of GDP prior to 2010 were substantial, with the level at the end of 2009 down by around 2 percent.

[6] The magnitude of the potential contribution in FRB/US is sensitive to assumptions about the interactions between the level of trend output and trends in other sectors, notably foreign activity and fiscal policy. In these calculations, we assume independent trends for domestic private output, government spending and foreign activity.

Moreover, as noted above, the calculations reported here take as given the staff's estimates for the path of potential output. Using alternative supply-side estimates, such as the FRB/US model's own estimates, would change not only the contribution of supply-side shocks, but also the contributions of other types of shocks, as the total contribution from all sources of shocks must equal the observed forecast revision.

Foreign Economic Activity

After factoring in the effects of historical revisions, the level of foreign economic activity in 2009 and 2010 was stronger, on average, than expected in the January 2010 forecast. However, the resulting upward revision to the estimated stimulus from this factor to the level of U.S. output in 2010 subsequently faded as fiscal and financial problems in Europe intensified and the growth of foreign activity weakened unexpectedly. By 2011 and 2012, foreign economic conditions (in both the past and the present, and including the effects of unanticipated movements in the dollar) are estimated to have been a sizeable drag on the level of real activity in the United States, relative to what was anticipated in early 2010. Viewed in terms of economic growth, unexpected changes in foreign demand (and the real exchange rate) contributed about ¾ percentage point, on average, to the downside surprise in the rate of real GDP growth in 2011 and 2012.

U.S. Fiscal Policy

As shown in the top panel of the table, revisions to the estimated stance of U.S. fiscal policy during the years prior to the recovery account for a small boost to the level of real GDP in 2010.[7] However, as shown in Figure 2, real federal, state, and local government purchases have been lower than was anticipated in early 2010. This subsequent shift toward more restrictive fiscal policy during the 2010-2012 period is greater than can be explained in FRB/US as an endogenous response to the slower-than-expected recovery. As indicated in the middle panel of Table 1, the model sees unexpectedly tight fiscal policy as having contributed more than ½ percentage point to the downward revision to real GDP growth in 2010 and 2011, although surprises to the stance of fiscal policy were a neutral factor for real GDP growth in 2012. As for the level of real GDP and the unemployment rate, the weaker path for fiscal policy after 2010 largely offsets the unexpected stimulus from earlier fiscal shocks, such that, by 2012, fiscal policy accounts for only a little of the staff's forecast error for either series.

Energy Prices

Energy prices were, on balance, higher than expected over the 2010-2012 period. As aggregate demand was weaker than forecast, the model infers substantial positive shocks to energy prices over these years. As a result, this unforeseen upward pressure on energy prices lowered the level of real GDP by about ¼ percentage point, on average, during the recovery, although their effects on the rate of growth in real GDP have been generally modest and offsetting during the recovery.

Private Domestic Demand

Spending on housing construction has been weaker than the staff projected in January 2010 and, indeed, weaker than the model can explain endogenously, even given the revised lower path for aggregate income. The unforeseen drag from the housing sector lowers the level of real GDP by about ¾ percentage point by the end of 2012, and has shaved roughly ½ percentage point, on average, from real GDP growth over the past three years.

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[7] The dominant contributions to this effect on the level of GDP were from upward revisions to estimates of state and local purchases and federal transfer payments in 2009.

Outside the housing sector, developments have been more favorable, at least given the more adverse conditions described previously. In particular, both consumer and business investment spending in 2010 and 2011 grew more rapidly than anticipated, given revisions to other conditioning variables. Similarly, in the model's view, the revision to business investment prior to 2010 was less drastic than can be explained by the revised path of output and other conditioning variables alone. Accordingly, the model infers that exogenous positive shocks to investment demand were greater than anticipated for several years before 2010. All told, this surprising unexplained strength in consumer spending and business investment boosted the level of GDP at the end of 2011 by 1½ percentage points and lowered the unemployment rate about ½ percentage point. However, this support to the level of real activity substantially diminished in 2012 as consumption and investment weakened unexpectedly relative to fundamentals.

Financial Conditions

Since early 2010, the staff has narrowed its estimates of the output gap prior to 2010; accordingly, the model views monetary policy as having been more accommodative prior to 2010 than previously estimated. While the model's reinterpretation of the stance of monetary policy implies a stronger boost from this factor to the level of GDP in 2010, the restraint on real GDP growth in 2010 and 2011 is estimated to be somewhat greater as the earlier additional monetary stimulus, and its effects on financial conditions, unwinds. However, the model sees overall financial conditions as more supportive in 2012, raising real GDP growth by more than ½ percentage point in 2012, as the term premium on long-term interest rates was sharply below what the model would predict endogenously, even given the revisions to current and expected economic activity (both important determinants of the term premium in the model). These unexplained revisions in the term premium presumably reflect both intensified flight-to-safety concerns and the effects of the Federal Reserve's asset purchases.

Conclusion

The analysis in this memo indicates that, from the perspective of the FRB/US model, the staff's revisions to its estimates of supply-side conditions explain a significant portion of the staff's forecast errors in real GDP and unemployment over the last three years. As mentioned above, some of the most consequential of these revisions were already implemented by September 2010, in response to the annual revision to the national accounts that year, while much of the subsequent revision has followed from the unexpected decline in the unemployment rate during the last year. As in these earlier instances, the staff will continue to make further adjustments as incoming data support them.

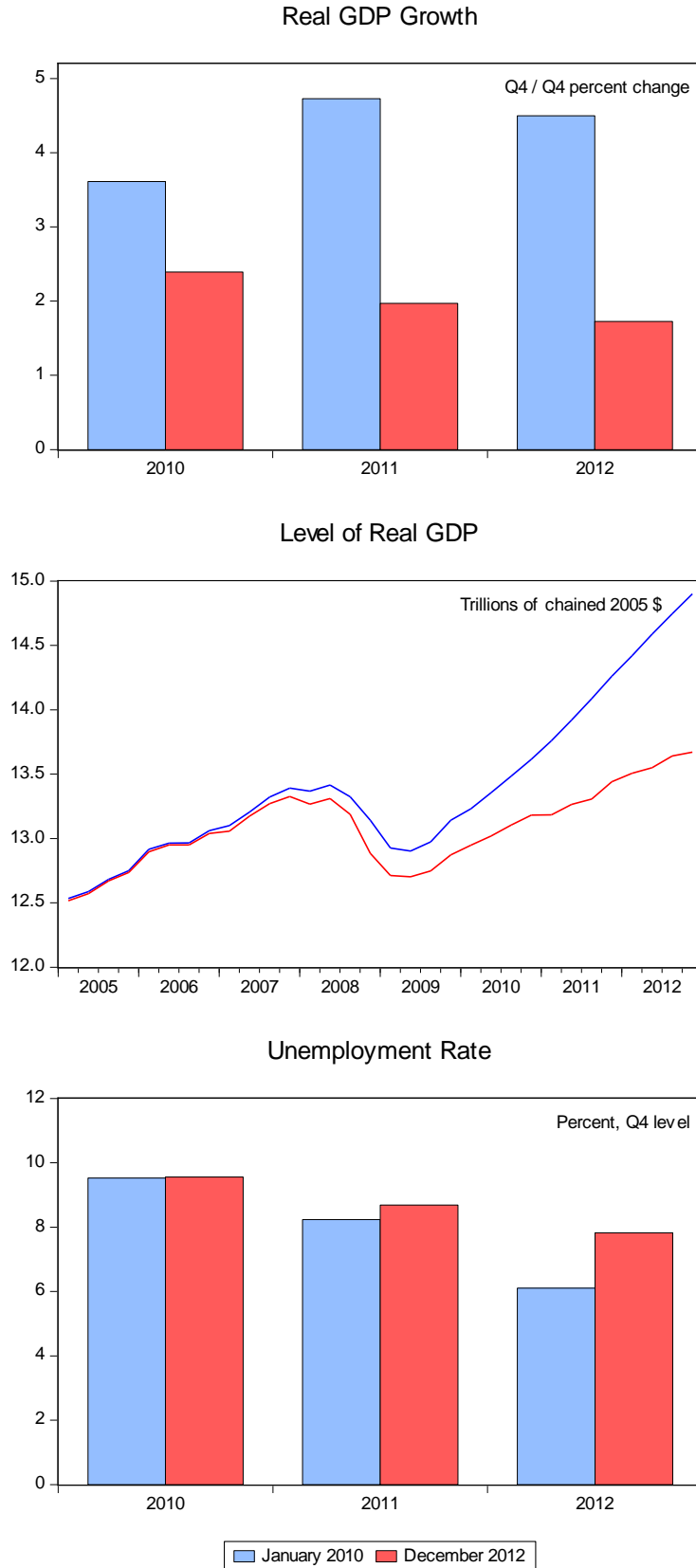# Figure 1: Evolution of the Staff Projection

Real GDP Growth

Q4 / Q4 percent change

Level of Real GDP

Trillions of chained 2005 $

Unemployment Rate

Percent, Q4 level

January 2010   December 2012

Figure 2: Revisions to Selected Conditioning Factors

Potential GDP

Potential GDP Growth

Natural Rate of Unemployment

Foreign GDP

Real Federal Government Purchases

Real State/ Local Purchases

January 2010   December 2012
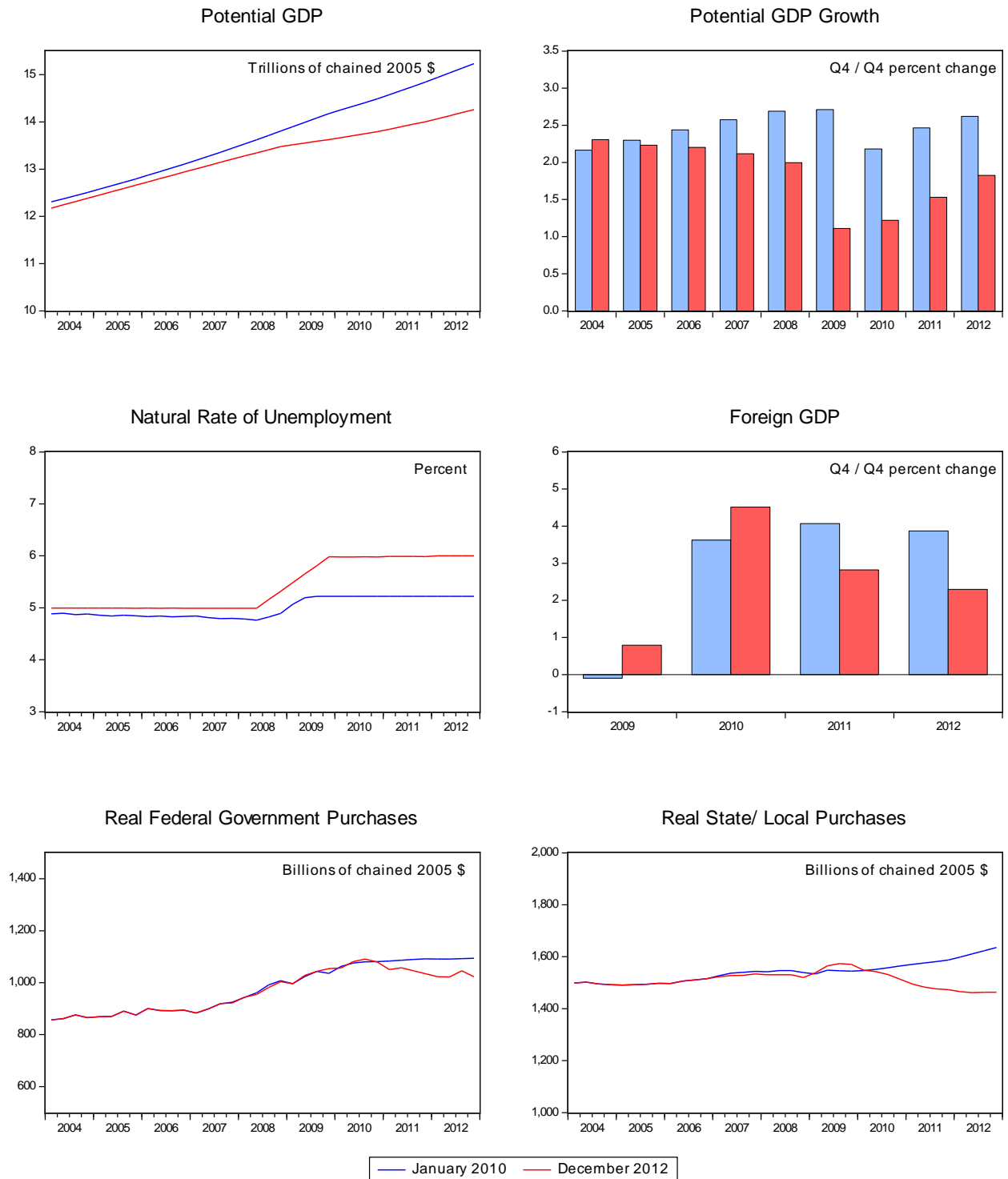
Table 1

FRB/US Decomposition of Revisions to the Staff's Forecast since January 2010

Level of Real GDP
(Deviation from January 2010 forecast; Percentage points)

Contribution to level of real GDP from:	Potential output	Foreign demand	Fiscal policy	Energy Prices	Consumption	Investment	Housing	Financial	Other	Total
2010:Q4	-5.3	.2	.4	-.2	.1	.6	.1	.2	.8	**-3.2**
2011:Q4	-6.1	-.4	-.2	-.5	.5	1.0	-.5	-.0	.5	**-5.7**
2012:Q4	-6.7	-1.4	-.1	-.2	-.1	.2	-.8	.5	.3	**-8.3**

Real GDP Growth Rate
(Q4/Q4 rate of change; Percentage points)

Contribution to growth of real GDP from:	Potential output	Foreign demand	Fiscal policy	Energy prices	Consumption	Investment	Housing	Financial	Other	Total
2010	-1.5	-.2	-.7	.0	.6	1.0	-.2	-.7	.5	**-1.2**
2011	-.9	-.6	-.6	-.3	.4	.3	-.7	-.2	-.2	**-2.8**
2012	-.8	-1.0	.1	.3	-.6	-.7	-.3	.6	-.2	**-2.8**

Unemployment Rate
(Percentage points)

Contribution to unemployment rate from:	Potential output	Foreign demand	Fiscal policy	Energy prices	Consumption	Investment	Housing	Financial	Other	Total
2010:Q4	.8	-.1	-.3	.1	.2	-.4	-.2	.1	-.2	**.1**
2011:Q4	.8	.1	.0	.3	-.1	-.5	.1	.3	-.5	**.5**
2012:Q4	.7	.6	.2	.2	.0	-.4	.4	.1	.1	**1.9**