Appendix to "Fiscal Forecasts at the FOMC: Evidence from the Greenbooks"

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This appendix provides a) details on data definitions and sources, b) complete results for the forecast error regressions, c) detailed results of the Romer-Romer regressions, d) the estimation and test results for a fiscal-policy augmented Taylor rule, and e) the results of Patton-Timmermann tests.

I. Greenbook Data

A. Sources and Sample

The Greenbook is a summary of economic conditions, trends and forecasts prepared for every meeting of the FOMC. Our primary data sources are page scans of each Greenbook made available by the Board of Governors of the Federal Reserve System[1] and by the Real Time Data Research Center at the Federal Reserve Bank of Philadephia.[2] These two sources provide independently-made page scans from different physical copies of the vintage historical materials; this allowed us to independently confirm figures which, on a few very rare occasions, were difficult to distinguish or missing in one of the two sources.[3]

The Greenbook was first prepared for the July 1966 FOMC meeting and the last we included was for the December 2010 meeting, covering 419 meetings of the FOMC over 44 years.[4] This represents the full set of source materials publically available as we write this. However, the earliest versions either lack fiscal variables or contain only very short time series (typically five quarters, most of which are historical estimates.) Most of our fiscal variables (Surplus, Revenues and Expenditures) first appeared in the August 1967 Greenbook while the first appearance of the HEB variable was in April 1970. FOMC meeting dates are slightly irregular, but for most of the period there were exactly two meetings per quarter. Meetings in the early part of the sample were more frequent (12 or more per year, but not necessarily one per month.) The release dates of key statistics

[1] `www.federalreserve.gov/monetarypolicy/fomc/`

[2] `www.philadelphiafed.org/research-and-data/real-time-center/greenbook-data/`

[3] Note that the Greenbook estimates published in the ALFRED database at the Federal Reserve Bank of St. Louis only contain figures from the main volumes of the Greenbook. This is compiled a few days prior to the meeting of FOMC; late-breaking developments (such as statistical releases or revisions) are collected and circulated in the form of a supplement to the Greenbook. Our data reflect the estimates presented to the FOMC; these incorporate any additions or revisions contained in supplements to the Greenbook.

[4] In June 2010, the Greenbook was merged with the Bluebook (a discussion of policy options) to form the Tealbook. As this is near the end of our sample period (December 2010), we continue to use the term Greenbook to mean the Greenbook prior to June 2010 and the Tealbook after that.

also vary somewhat over the years. To standardize the forecast horizons we examine, we restrict our analysis to the vintages from the first and the last FOMC meeting of each quarter. A list of data vintage rangesdates is provided below in Table 1.

Table 1—Available Data Vintages (FOMC Meeting Dates)

Series	First Vintage	Last Vintage
Surplus	August 1967	December 2010
Receipts	August 1967	December 2010
Expenditures	August 1967	December 2010
Unemployment	July 1966	December 2010
GDP (nominal)	July 1966	December 2010
HEB	April 1970	December 2010
HEB (6%)	November 1980	December 2010

The number of observations and the forecast horizons included in each series varied considerably over time. Our figures were principally compiled from the *Federal Sector Accounts* and *Main Economic Indicators* tables (whose contents varied somewhat over the years.) When series were shown in both tables, we collected data from both to maximize the span of observations available. In some of the earliest vintages, series might not contain more than 5 quarters of historical estimates and forecasts, whereas later vintages could contain up to 20 quarters. Greenbooks often had slightly more quarters of historical estimates than of forecasts, as can be seen in Table 2, which gives one example of the number of available forecasts for each forecast horizon (in quarters).

B. Validation

The data were validated in a number of ways.

1.) A professional data-entry firm was employed for initial key-input of the data with a contracted accuracy rate $\geq 99.95\%$.

2.) Several of their series were then checked against independent sources. This verified the claimed accuracy rate.

2a) Unemployment rates, as well as nominal and real levels of GNP and GDP were checked against estimates published in ALFRED by the FRB St. Louis. We found 10 cases where the figures in ALFRED did not correspond to the page scans, one case where we had matched Greenbook data to the wrong quarters, and one case where we had missed an entry.[5] We also found a number of cases where the FOMC and the FRB Philadelphia page scans disagreed. In those cases,

[5]We communicated our findings to the FRB St. Louis, who verified our figures and corrected the entries in ALFRED. Note that with slightly more than 5000 data points checked, this implies a pre-correction error rate for Greenbook series in ALFRED of $< 0.2\%$ and $< 0.1\%$ for our data entry.

Table 2—Number of Observations by Forecast Horizon: Govt. Receipts

Forecast Horizon	First Meeting	Last Meeting	Forecast Horizon	First Meeting	Last Meeting
-12	0	0	**12**	0	0
-11	2	0	**11**	0	0
-10	3	2	**10**	0	0
-9	3	3	**9**	3	20
-8	3	3	**8**	25	44
-7	3	3	**7**	47	66
-6	20	3	**6**	78	102
-5	48	23	**5**	111	121
-4	85	57	**4**	134	148
-3	136	104	**3**	157	168
-2	168	159	**2**	167	169
-1	174	173	**1**	170	174
0	174	174			

the FRB Philadelphia page scans were dated slightly after the original Greenbook estimates, indicating that figures were revised just prior to the FOMC meeting. We used the latter.

2b) HEB estimates were checked against estimates entered independently.[6] Of approximately 3,000 data points, we found and corrected 10 discrepencies (0.3%); three were due to incorrect or missing meeting dates, five were due to keying errors in the independent estimates, and the remainder due to illegible page scans.

3.) There were a small number of cases in which figures shown in the *Federal Sector Accounts* Table were not precisely the same as those shown in *Main Economic Indicators* Table of the same Greenbook. One possibility is that the two tables may have been prepared by different groups; older Greenbooks were compiled by hand and slight discrepancies may have arisen in preparation.

4.) We verified that the Surplus/Deficit data were consistent with the data for Receipts and Expenditures.[7]

C. Forecasts

We recorded all Greenbook estimates for our selected series. This included estimates for future periods (forecasts), current periods (nowcasts) and historical periods (backcasts). In this appendix, we collectively refer to all of these as *forecasts* although some prefer the term "projection" to emphasize the conditional nature of these estimates. Forecast horizons varied widely from meeting to

[6]The authors would like to thank Wendy Chan of the Bank of Canada for her research assistance.

[7]Figures in the Greenbook for May 1999 incorrectly reversed the sign on the Surplus. We corrected the sign.

meeting. At times, the convention was that the forecast horizon was fixed to the end of a given calendar year, then rolled forward once a year. This meant that the length of the forecast horizon varied somewhat through the year. There was also a general tendency for forecast and backcast horizons to increase across the decades, although there were some occasions when the horizons were decreased (perhaps because the longest horizons were not felt to be useful). When series were listed in more than one table, different tables might include different forecast horizons. As the content of the tables evolved over time, the available forecast horizons might therefore vary from series to series.

D. Outcomes

Forecast evaluation requires a measure of observed outcomes. One of the series we collect (HEB) has no officially published value; it is only calculated by Board staff. While the other series correspond to official statistics, values published for the latter are revised over time. These revisions may reflect the incorporation of new information as published preliminary estimates are refined in the quarters immediately following their initial publication. It may also reflect conceptual changes in the definition of the series, such as the change from GNP to GDP or from a fiscal surplus to a fiscal current account surplus. We refer to the latter as "benchmark" revisions. Each of our series were affected, to greater or lesser degrees, by benchmark changes. This complicates the measurement of forecast outcomes. We therefore use a variety of different "outcome" concepts to provide alternative characterizations of forecast performance. They are

First Release: This is the initial quarterly estimate published by the responsible official statistical agency (BEA or BLS).

One Year: This is the official quarterly estimate that was available precisely one year after the publication of the First Release. For example, if the First Release was published on September 23, 1998, and revisions were published on August 26, 1999, and September 29, 1999, the August 1999 estimate would be the One Year estimate. This typically incorporates the annual revision common to most official series.

Last Greenbook: This is the last value recorded in the Greenbook, typically one or more years after the quarter to which it refers. This is primarily important as a measure for HEB, which has no counterpart in official statistics.

Pre-Benchmark: This is the last official estimate reported prior to a benchmark revision of the series. This is intended to capture the most precise available estimate of the same concept that the staff were forecasting and has previously been used in the literature to measure data revisions.[8] We discuss the identification and importance of benchmark revisions below.

Final: This is a "contemporary" estimate, which in our case was the official estimate as of December 27, 2012.

[8]For example, see Aruoba (2008).

E. Benchmark Revisions

We use the extent of revision to define those which we treat as *benchmark* revisions. Benchmark revisions are those which affect a significant portion of the published history of a time series. For example, US Quarterly National Accounts are available starting from 1946Q1. Revisions which do not affect the published estimates for more than five years are therefore not considered benchmark revisions. Changes in seasonal adjustment factors, although they may occur many years after the fact, are not counted as benchmark revisions. Changes in base years (for real values), or the change from fixed-weight to chain-weighted values, or the change from GNP to GDP, are all examples of benchmark changes. This definition of benchmark revision has at least two important advantages.

1.) It is a simple, transparent and objective way to determine which revisions are treated as benchmark revisions.

2.) It implicitly relies on the judgement of the statistical agency to determine which methodological or conceptual changes are important enough to be considered benchmark changes. In effect, if the statistical agency judges that historical estimates are sufficiently comparable to current estimates that no revision to the former is required, no benchmark revision has occured.

This definition also has at least one important drawback: since no official series is published for HEB, no long time series are available to identify benchmark changes. As we describe below, we therefore treat HEB estimates somewhat differently.

The economic importance of benchmark revisions varied vastly across our series, as we describe below in greater detail. At one extreme, benchmark revisions in the unemployment rate were rare and trivial. In contrast, the redefinition of the government accounts had an important impact on our fiscal variables. We discuss the economic importance of benchmark revisions in the next subsection. Table 3 shows the dates at which benchmark revisions were first published for each series.

Values forecast prior to benchmark revision are not comparable to outcomes measured after a benchmark revision. For that reason, whenever a forecast or nowcast is made for an outcome that will only be observed after a benchmark revision has occurred, we drop those forecast errors from our data set. For example, the Greenbook for the FOMC meeting in October 1975 contained nowcasts and forecasts for the period 1975Q4-1976Q4. Estimates for most of these outcomes were only published after the benchmark revision which was first released on January 20, 1976. Therefore, for the series affected by those benchmark changes, those forecast errors were replaced by a missing value code.

F. Variables

GNP and GDP: Our outcome measures for these series were taken from ALFRED series *GNP* and *GDP.* The BEA published estimates of GNP until December 1991, after which it switched to GDP as its main measure of economic

Table 3—Pre-Benchmark-Revision Dates for Quarterly National Accounts

Last Quarter	Last ALFRED Vintage	Last FOMC Date
1975:3	Dec. 19, 1975	Dec. 10, 1975
1980:3	Nov. 19, 1980	Dec, 12, 1980
1985:3	Nov. 20, 1985	Dec. 11, 1985
1991:2	Aug. 28, 1991	Oct. 30, 1991
1995:2	Oct. 27, 1995	Dec. 14, 1995
1999:2	Sep. 30, 1999	Sep. 29, 1999
2003:3	Nov. 25, 2003	Dec. 03, 2003

Note: This table gives the dates of publication for the last estimates prior to benchmark revisions of the National Accounts. The first column gives the last time period to which those estimates correspond. The second column gives the date at which those estimates were published. The last column gives the date of the last FOMC meeting prior to the publication of the benchmark revision. These dates apply to figures from the Quarterly National Accounts as based on original data vintages from ALFRED and the FRB Philadelphia Real-Time Data Set for Macroeconomists. The 1995 benchmark revision of Expenditures occurred slightly after the revision of the other series; its last pre-benchmark-revision quarter was 1995:3 which was published on October 27, 1995. The last FOMC meeting using this estimate was that of December 1995.

activity. The Greenbooks followed suit, focusing on GNP until that date and GDP thereafter. Our primary use of these series is to express various fiscal series as a fraction of the overall size of the US economy, for which we need an estimate of the level of the series. After August 2005, Greenbooks no longer list GDP in levels, giving only growth rate forecasts. For the remaining FOMC meetings we recorded, we therefore calculated an implied level GDP forecast from the growth rate forecasts by applying the compound growth rate to the second-to-last (and therefore already revised) officially published estimate. For example, the growth rate estimates from the September 2005 Greenbook are applied to the August 31, 2005 vintage BEA estimate of GDP. The last estimate in that vintage is for 2005Q2; we therefore use the 2005Q1 estimate of 12198.8 as our base.

Receipts, Expenditures and Surplus/Deficit: Outcomes for the Surplus/Deficit were measured by ALFRED series *FGDEF: Net Federal Government Saving*. Outcomes for Receipts were taken from *FGRECPT: Federal Government Current Receipts*, and for Expenditures from *FGEXPND: Federal Government: Current Expenditures*.

HEB: The *High-Employment Budget Surplus/Deficit* (HEB) is the Greenbook's estimate of a cyclically-adjusted or "structural" budget deficit. This is the Board staff's counterfactual estimate of what the surplus (or deficit) would be if the unemployment rate were at a constant reference level over the forecast horizon. The budget deficit concept used in HEB always corresponds to that used in the Surplus/Deficit measure; prior to 1996 this was the overall Surplus or Deficit, and this was replaced by the Government Current Account Surplus/Deficit thereafter.

The reference level of unemployment used to calculate HEB is not always explicitly mentioned, but drifted upwards from near 4.0% in the earliest part of our sample before major changes were introduced in 1980. From November 1980

until March 1983, two alternative HEB estimates were presented, based on a 6.1% and a 5.1% reference level of unemployment. From May 1983 until August 1983 these were replaced by rates of 6.0% and 5.0%. Thereafter, the reference level was constant at 6.0%. We assume that these changes reflected uncertainty and disagreement within the Board about the natural rate of unemployment. The table design during the "dual-rate" period gave greater prominence to the 6.1% (and then the 6.0%) reference level.

We found that the revision of the reference level of unemployment appeared to have a qualitatively important effect on the HEB estimates. We therefore consider two different sets of HEB estimates; the full series as well as the subset (HEB6) which only considers those estimates based on a 6.0% or 6.1% reference level. We make no attempt to adjust the HEB6 series for the change from 6.1% to 6.0%. We also calculate the difference between the HEB (and HEB6) estimates and the overall Surplus/Deficit estimates as the Board Staff's implied estimate of the cyclical Surplus/Deficit.

Unemployment: Outcomes for this series were measured by ALFRED series *UNRATE: the Civilian Unemployment Rate.* Greenbooks only report the unemployment rate to one decimal place. Starting with the official estimate published on Feb. 9, 1967, the labor force was redefined to count only those age 16 and over instead of 14 and over. This never caused revisions of more than 0.1% in absolute value in our data set. There were no benchmark revisions to unemployment after that date. We therefore chose to ignore benchmark revisions in the unemployment rate and do not use a "Pre-Benchmark" measure of outcomes.

II. Forecast Error Regression Tables

The following tables provide details on the relationships between the forecast errors for fiscal variables and other key macroeconomic variables discussed in Section V of the paper.

As headline variables, we used two inflation measures (CPI and the GDP deflator) and three real activity measures (real GDP growth, the unemployment rate and the output gap.) Unemployment rates were collected directly from Greenbooks and checked against those available from the Federal Reserve Bank of St. Louis ALFRED database. Greenbook forecasts forecasts for the other variables were taken from the Federal Reserve Bank of Philadelphia Greenbook database. Published series for CPI inflation and the unemployment rate undergo little revision; we used July 2016 vintage data from FRED (series UNRATE and CPIAUCSL) to measure outcomes for these varibles. What we refer to as real GDP growth and the GDP deflator in fact uses GNP data prior to 1992 (series GNPC96 and GNPDEF) and GDP thereafter (series GDPC1 and GDPDEF.) Outcomes were measured using pre-benchmark vintages of output from the Federal Reserve Bank of St. Louis ALFRED database. The Board Staff's estimates of the output gap are those made available by the Federal Reserve Bank of Philadelphia. Outcomes for the output gap were measured by the last-reported Greenbook value.

TABLE 4—GREENBOOK FORECAST ERRORS FOR PCPI INFLATION

PCPI Inflation = $\alpha + \beta \cdot$ HEB6

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.031	18.7	1.707	0.205	65.0	2.411	0.000	0.3	0.063
0Q First	0.018	26.5	1.508	0.045	71.1	2.227	0.006	9.4	0.511
1Q Last	0.040	45.2	1.401	0.185	164.4	4.335	0.005	11.1	0.365
1Q First	0.040	55.8	1.862	0.133	169.4	9.063	0.008	18.6	0.575
2Q Last	0.010	23.9	0.939	0.033	92.6	1.657	0.003	9.2	0.292
2Q First	0.003	13.1	0.486	0.030	85.2	1.466	0.000	-1.0	-0.032
3Q Last	0.002	9.3	0.386	0.035	82.3	1.075	0.001	-3.7	-0.128
3Q First	0.000	0.9	0.037	0.032	78.3	4.376	0.007	-12.9	-0.435
4Q Last	0.001	6.4	0.456	0.004	-35.5	-0.556	0.004	7.7	0.366
4Q First	0.006	13.3	0.877	0.039	92.9	0.000	0.003	6.5	0.320

PCPI Inflation = $\alpha + \beta \cdot$ HEB

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.083	26.8	3.015	0.254	53.1	4.225	0.000	0.3	0.063
0Q First	0.066	42.3	2.338	0.103	68.8	3.037	0.006	9.4	0.511
1Q Last	0.079	56.1	2.081	0.188	113.0	3.214	0.005	11.1	0.365
1Q First	0.044	56.4	1.596	0.057	87.3	1.455	0.008	18.6	0.575
2Q Last	0.012	23.4	0.665	0.008	26.8	0.325	0.003	9.2	0.292
2Q First	0.001	7.6	0.267	0.000	5.4	0.100	0.000	-1.0	-0.032
3Q Last	0.001	6.5	0.437	0.000	3.9	0.275	0.001	-3.7	-0.128
3Q First	0.001	-6.1	-0.484	0.006	-17.9	-1.181	0.007	-12.9	-0.435
4Q Last	0.000	0.9	0.076	0.022	-35.5	-1.282	0.004	7.7	0.366
4Q First	0.002	6.9	0.921	0.003	-11.8	-1.052	0.003	6.5	0.320

PCPI Inflation = $\alpha + \beta \cdot$ SURPLUS

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.047	29.4	1.549	0.295	88.8	3.577	0.001	-3.9	-0.472
0Q First	0.019	30.7	1.560	0.061	76.0	3.284	0.001	4.5	0.199
1Q Last	0.021	35.8	1.424	0.091	102.2	2.513	0.000	0.9	0.048
1Q First	0.026	50.8	1.356	0.101	146.6	2.178	0.000	-1.1	-0.060
2Q Last	0.000	3.3	0.152	0.015	45.9	0.545	0.002	-7.2	-0.357
2Q First	0.000	2.2	0.093	0.034	55.7	0.731	0.010	-13.6	-0.774
3Q Last	0.000	3.4	0.248	0.048	63.9	1.172	0.005	-7.7	-0.540
3Q First	0.000	2.4	0.178	0.051	63.0	1.742	0.006	-8.9	-0.595
4Q Last	0.010	13.3	1.113	0.097	93.8	1.709	0.002	3.9	0.430
4Q First	0.016	16.0	1.291	0.130	98.4	3.240	0.002	3.9	0.530

Note: This table reports the results of regressions of Greenbook CPI inflation rate forecast errors on forecast errors for the variables shown in the table. Estimation is by OLS, with HAC standard errors used to calculate the t-statistics. The number of lags used was equal to $2(h+1)$ where h is the forecast horizon rounded to the nearest quarter. Under the **Horizon** heading, "First" and "Last" indicate whether the forecast was made during the first or last meeting of the quarter.

TABLE 5—GREENBOOK FORECAST ERRORS FOR PGDP INFLATION

PGDP Inflation = $\alpha + \beta \cdot$ HEB6

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.003	9.3	0.484	0.055	61.7	2.171	0.008	-11.7	-0.477
0Q First	0.007	15.5	0.670	0.027	44.3	0.915	0.001	4.0	0.159
1Q Last	0.000	2.6	0.116	0.025	38.9	1.873	0.004	-8.3	-0.304
1Q First	0.007	15.4	0.843	0.007	20.2	0.000	0.004	10.8	0.467
2Q Last	0.001	5.3	0.335	0.012	26.3	0.000	0.000	-0.7	-0.034
2Q First	0.001	4.3	0.249	0.027	45.1	7.961	0.001	-4.3	-0.205
3Q Last	0.002	6.3	0.333	0.043	51.5	1.403	0.000	-2.1	-0.095
3Q First	0.001	5.0	0.251	0.039	50.1	2.096	0.001	-3.5	-0.147
4Q Last	0.001	3.0	0.153	0.000	-1.7	-0.107	0.001	2.8	0.118
4Q First	0.001	-4.0	-0.224	0.062	-64.6	-8.193	0.000	0.2	0.011

PGDP Inflation = $\alpha + \beta \cdot$ HEB

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.026	27.7	1.454	0.079	55.2	2.409	0.008	-11.7	-0.477
0Q First	0.077	52.4	1.857	0.157	83.7	2.231	0.001	4.0	0.159
1Q Last	0.081	50.8	1.810	0.208	91.2	3.120	0.004	-8.3	-0.304
1Q First	0.103	64.6	1.693	0.214	102.1	2.199	0.004	10.8	0.467
2Q Last	0.066	47.7	1.273	0.165	88.5	2.052	0.000	-0.7	-0.034
2Q First	0.077	52.2	1.229	0.204	99.5	2.125	0.001	-4.3	-0.205
3Q Last	0.070	49.2	1.109	0.184	97.0	1.817	0.000	-2.1	-0.095
3Q First	0.049	39.7	1.088	0.157	88.2	1.950	0.001	-3.5	-0.147
4Q Last	0.031	29.9	0.896	0.109	74.0	1.808	0.001	2.8	0.118
4Q First	0.031	29.1	0.920	0.113	72.5	1.552	0.000	0.2	0.011

PGDP Inflation = $\alpha + \beta \cdot$ SURPLUS

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.001	-5.7	-0.279	0.003	-15.1	-0.430	0.001	4.3	0.204
0Q First	0.001	7.9	0.353	0.000	0.7	0.023	0.010	18.0	0.626
1Q Last	0.003	10.0	0.648	0.007	16.2	0.909	0.004	-9.6	-0.412
1Q First	0.022	27.2	2.148	0.027	31.3	2.416	0.005	11.3	0.509
2Q Last	0.030	27.4	2.291	0.052	41.2	3.441	0.000	-0.7	-0.039
2Q First	0.029	26.9	1.768	0.059	43.3	3.341	0.002	-4.3	-0.255
3Q Last	0.027	24.2	1.712	0.058	43.3	6.307	0.001	-3.1	-0.207
3Q First	0.017	18.5	1.347	0.047	37.7	5.958	0.003	-4.5	-0.268
4Q Last	0.021	18.7	1.354	0.053	40.9	4.518	0.000	-1.0	-0.068
4Q First	0.021	18.6	1.308	0.061	44.8	4.068	0.001	-1.9	-0.147

Note: This table reports the results of regressions of Greenbook output deflator forecast errors on forecast errors for the variables shown in the table. Estimation is by OLS, with HAC standard errors used to calculate the t-statistics. The number of lags used was equal to $2(h+1)$ where h is the forecast horizon rounded to the nearest quarter. Under the **Horizon** heading, "First" and "Last" indicate whether the forecast was made during the first or last meeting of the quarter.

TABLE 6—GREENBOOK FORECAST ERRORS FOR REAL GDP GROWTH

RGDP = $\alpha + \beta \cdot$ HEB6

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.000	2.4	0.077	0.007	21.0	0.699			
0Q First	0.003	18.5	0.531	0.004	-32.5	-0.284	0.015	35.6	1.180
1Q Last	0.014	40.9	1.153	0.001	19.4	0.153	0.024	44.0	1.475
1Q First	0.005	25.6	0.595	0.002	28.3	0.265	0.005	20.8	0.440
2Q Last	0.002	15.9	0.332	0.009	-68.4	-0.433	0.010	28.0	0.590
2Q First	0.005	24.4	0.556	0.044	-155.0	-1.130	0.032	49.0	1.627
3Q Last	0.021	43.8	1.168	0.009	-56.3	-0.409	0.059	58.6	1.835
3Q First	0.032	53.4	1.464	0.010	-56.6	-0.888	0.082	69.6	2.207
4Q Last	0.052	58.3	2.402	0.005	53.5	0.000	0.087	59.0	2.291
4Q First	0.076	66.8	2.532	0.071	156.4	2.970	0.099	60.2	2.093

RGDP = $\alpha + \beta \cdot$ HEB

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.007	-26.3	-1.031	0.007	21.0	0.699			
0Q First	0.015	-46.8	-1.277	0.052	-100.2	-2.391	0.015	35.6	1.180
1Q Last	0.012	-39.5	-1.065	0.060	-96.0	-2.460	0.024	44.0	1.475
1Q First	0.013	-42.6	-0.958	0.044	-87.7	-1.680	0.005	20.8	0.440
2Q Last	0.007	-30.8	-0.831	0.028	-72.6	-2.115	0.010	28.0	0.590
2Q First	0.024	-58.4	-1.159	0.094	-133.7	-3.256	0.032	49.0	1.627
3Q Last	0.040	-72.7	-1.111	0.164	-176.2	-3.135	0.059	58.6	1.835
3Q First	0.021	-51.0	-0.805	0.134	-156.7	-2.990	0.082	69.6	2.207
4Q Last	0.006	-24.3	-0.496	0.085	-117.2	-3.514	0.087	59.0	2.291
4Q First	0.003	-13.8	-0.290	0.100	-98.7	-2.447	0.099	60.2	2.093

RGDP = $\alpha + \beta \cdot$ SURPLUS

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.026	67.2	1.702	0.006	24.3	0.453			
0Q First	0.069	114.2	2.079	0.124	166.6	2.415	0.002	15.3	0.317
1Q Last	0.044	76.6	2.675	0.054	91.1	2.458	0.031	54.4	1.783
1Q First	0.041	69.0	2.414	0.064	90.4	3.582	0.005	20.6	0.356
2Q Last	0.036	59.8	2.608	0.048	77.3	2.994	0.016	30.6	0.797
2Q First	0.025	49.5	2.077	0.023	53.4	1.820	0.040	45.5	1.263
3Q Last	0.007	24.8	1.247	0.001	9.7	0.827	0.062	45.9	1.541
3Q First	0.016	35.1	1.285	0.002	15.7	0.454	0.108	57.9	2.033
4Q Last	0.008	22.1	0.712	0.001	-7.9	-0.168	0.107	46.5	2.167
4Q First	0.021	28.9	1.269	0.001	8.7	0.275	0.115	44.7	2.032

Note: This table reports the results of regressions of Greenbook real output forecast errors on forecast errors for the variables shown in the table. Estimation is by OLS, with HAC standard errors used to calculate the t-statistics. The number of lags used was equal to $2(h+1)$ where h is the forecast horizon rounded to the nearest quarter. Under the **Horizon** heading, "First" and "Last" indicate whether the forecast was made during the first or last meeting of the quarter.

TABLE 7—GREENBOOK FORECAST ERRORS FOR OUTPUT GAPS

YGAP = $\alpha + \beta \cdot$ HEB6

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.035	-20.0	-2.024	0.000	-1.8	-0.045	0.044	-21.3	-2.057
0Q First	0.005	-8.1	-0.682	0.015	29.0	0.687	0.009	-9.7	-0.772
1Q Last	0.003	-6.6	-0.558	0.019	44.7	0.615	0.006	-8.2	-0.702
1Q First	0.001	-3.4	-0.346	0.035	77.5	0.000	0.002	-5.5	-0.554
2Q Last	0.013	12.8	0.985	0.237	164.1	0.000	0.009	9.7	0.859
2Q First	0.023	19.3	2.037	0.417	362.2	0.000	0.019	15.6	2.306
3Q Last	0.071	31.2	1.606	0.328	198.5	0.000	0.069	28.2	1.568
3Q First	0.100	42.1	2.233	0.148	196.6	$> 10^6$	0.111	40.8	2.398
4Q Last	0.160	46.6	1.739	0.452	218.5	$> 10^6$	0.159	44.4	1.713
4Q First	0.212	57.9	2.178	0.331	382.8	$> 10^6$	0.228	56.5	2.208

YGAP = $\alpha + \beta \cdot$ SURPLUS

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.038	25.9	1.705	0.249	77.4	2.564	0.022	19.4	1.091
0Q First	0.063	32.0	2.215	0.351	100.5	3.786	0.037	23.3	1.270
1Q Last	0.060	30.9	2.445	0.492	150.9	4.013	0.037	22.8	1.696
1Q First	0.073	33.7	2.057	0.669	174.8	4.573	0.035	21.2	1.311
2Q Last	0.140	37.2	2.725	0.741	158.5	6.874	0.108	30.4	2.541
2Q First	0.180	43.4	2.955	0.865	175.4	9.494	0.135	34.4	2.957
3Q Last	0.250	44.2	2.999	0.761	144.2	9.498	0.225	39.2	3.031
3Q First	0.301	52.2	3.715	0.827	166.4	0.000	0.278	47.0	4.120
4Q Last	0.339	48.7	3.257	0.678	139.9	$> 10^6$	0.333	45.6	3.365
4Q First	0.387	54.3	3.721	0.651	158.0	$> 10^6$	0.391	50.9	4.067

Note: This table reports the results of regressions of Greenbook output gap forecast errors on forecast errors for the variables shown in the table. Estimation is by OLS, with HAC standard errors used to calculate the t-statistics. The number of lags used was equal to $2(h+1)$ where h is the forecast horizon rounded to the nearest quarter. Under the **Horizon** heading, "First" and "Last" indicate whether the forecast was made during the first or last meeting of the quarter.

Table 8—Greenbook Forecast Errors for Output Gaps (cont.)

YGAP = $\alpha + \beta \cdot$ RECEIPT

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.062	38.4	3.057	0.000	-0.8	-0.043	0.083	42.6	3.303
0Q First	0.052	36.9	2.098	0.001	-8.2	0.000	0.078	42.5	2.262
1Q Last	0.045	37.6	2.519	0.057	-63.6	-5.743	0.077	46.4	3.276
1Q First	0.026	27.1	1.924	0.011	-36.4	-2.397	0.042	30.8	2.103
2Q Last	0.082	40.6	2.438	0.124	-147.1	-2.724	0.118	44.6	2.451
2Q First	0.081	43.4	5.085	0.051	-124.1	-2.483	0.115	46.2	4.472
3Q Last	0.130	48.7	3.830	0.050	-116.3	-2.563	0.165	50.5	3.566
3Q First	0.141	56.4	4.737	0.007	-49.7	$< -10^6$	0.171	57.1	4.365
4Q Last	0.210	60.9	3.395	0.002	25.2	$> 10^6$	0.232	61.0	3.286
4Q First	0.226	68.3	4.069	0.000	-9.2	0.000	0.256	68.7	3.912

YGAP = $\alpha + \beta \cdot$ EXPEND

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.000	1.9	0.075	0.217	-67.3	-1.605	0.012	17.5	0.606
0Q First	0.010	-15.3	-0.626	0.403	-109.9	-2.484	0.001	4.0	0.128
1Q Last	0.023	-26.6	-1.132	0.503	-121.0	-2.966	0.001	-4.8	-0.161
1Q First	0.047	-38.5	-1.699	0.630	-150.6	-4.005	0.003	-9.2	-0.290
2Q Last	0.079	-46.3	-2.093	0.807	-146.6	-7.201	0.020	-23.3	-0.886
2Q First	0.138	-62.0	-2.314	0.868	-163.0	-9.918	0.050	-37.0	-1.335
3Q Last	0.207	-70.5	-2.379	0.909	-159.3	-9.925	0.135	-56.1	-2.078
3Q First	0.283	-87.4	-2.782	0.956	-186.9	$< -10^6$	0.215	-74.3	-2.837
4Q Last	0.286	-77.2	-2.621	0.781	-136.4	0.000	0.251	-71.9	-2.564
4Q First	0.360	-87.2	-3.093	0.900	-165.8	$< -10^6$	0.318	-80.5	-3.267

Note: This table reports the results of regressions of Greenbook output gap forecast errors on forecast errors for the variables shown in the table. Estimation is by OLS, with HAC standard errors used to calculate the t-statistics. The number of lags used was equal to $2(h+1)$ where h is the forecast horizon rounded to the nearest quarter. Under the **Horizon** heading, "First" and "Last" indicate whether the forecast was made during the first or last meeting of the quarter.

TABLE 9—GREENBOOK FORECAST ERRORS FOR UNEMPLOYMENT RATE

UNEMP = $\alpha + \beta \cdot$ HEB6

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.009	1.5	0.932	0.000	0.4	0.149	0.015	1.7	0.961
0Q First	0.009	-2.7	-0.819	0.000	0.2	0.050	0.027	-3.8	-0.967
1Q Last	0.011	-3.5	-1.210	0.028	-9.8	-0.983	0.007	-2.0	-0.753
1Q First	0.045	-10.2	-2.150	0.055	-19.7	-1.718	0.054	-8.1	-1.378
2Q Last	0.015	-6.8	-1.607	0.000	-2.7	-0.204	0.057	-7.4	-1.394
2Q First	0.010	-6.3	-0.854	0.006	12.1	0.354	0.055	-8.8	-1.434
3Q Last	0.027	-11.1	-1.315	0.001	6.2	0.206	0.127	-13.7	-1.566
3Q First	0.025	-11.7	-1.099	0.023	27.0	1.277	0.131	-17.1	-1.666
4Q Last	0.064	-16.6	-1.172	0.297	112.1	2.143	0.244	-23.7	-1.859
4Q First	0.080	-20.1	-1.444	0.186	78.7	0.000	0.277	-27.8	-2.270

UNEMP = $\alpha + \beta \cdot$ HEB

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.007	1.4	1.785	0.001	0.7	0.916	0.015	1.7	0.961
0Q First	0.003	1.8	0.689	0.020	5.1	2.794	0.027	-3.8	-0.967
1Q Last	0.000	-0.1	-0.056	0.001	1.0	0.266	0.007	-2.0	-0.753
1Q First	0.005	-3.5	-0.762	0.000	-1.0	-0.173	0.054	-8.1	-1.378
2Q Last	0.019	-6.9	-1.112	0.012	-6.8	-0.713	0.057	-7.4	-1.394
2Q First	0.007	-4.8	-0.940	0.001	-2.0	-0.257	0.055	-8.8	-1.434
3Q Last	0.018	-8.0	-1.430	0.004	-4.3	-0.548	0.127	-13.7	-1.566
3Q First	0.013	-7.6	-1.049	0.000	-0.6	-0.055	0.131	-17.1	-1.666
4Q Last	0.023	-9.9	-0.918	0.000	1.5	0.092	0.244	-23.7	-1.859
4Q First	0.025	-10.4	-0.889	0.004	5.0	0.331	0.277	-27.8	-2.270

UNEMP = $\alpha + \beta \cdot$ SURPLUS

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.001	0.7	0.402	0.001	1.1	0.393	0.003	1.0	0.441
0Q First	0.067	-9.5	-1.683	0.127	-14.3	-1.920	0.001	0.8	0.268
1Q Last	0.080	-10.6	-2.258	0.116	-14.3	-2.274	0.012	-2.7	-1.169
1Q First	0.223	-20.8	-3.059	0.310	-26.2	-3.351	0.037	-6.7	-2.229
2Q Last	0.260	-22.1	-3.476	0.330	-28.9	-4.123	0.147	-10.5	-3.321
2Q First	0.302	-26.1	-4.127	0.381	-33.9	-4.690	0.186	-13.3	-3.322
3Q Last	0.348	-28.0	-3.845	0.420	-37.4	-4.403	0.296	-16.0	-3.232
3Q First	0.393	-32.3	-3.983	0.478	-43.5	-4.583	0.333	-19.8	-3.886
4Q Last	0.380	-31.1	-4.177	0.410	-41.6	-4.223	0.429	-22.3	-3.539
4Q First	0.410	-32.5	-4.464	0.420	-43.0	-3.839	0.478	-25.2	-4.438

Note: This table reports the results of regressions of Greenbook unemployment rate forecast errors on forecast errors for the variables shown in the table. Estimation is by OLS, with HAC standard errors used to calculate the t-statistics. The number of lags used was equal to $2(h+1)$ where h is the forecast horizon rounded to the nearest quarter. Under the **Horizon** heading, "First" and "Last" indicate whether the forecast was made during the first or last meeting of the quarter.

TABLE 10—GREENBOOK FORECAST ERRORS FOR UNEMPLOYMENT RATE (CONT.)

UNEMP = $\alpha + \beta \cdot$ RECEIPT

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.001	0.8	0.526	0.006	3.0	1.212	0.016	-2.6	-1.659
0Q First	0.054	-12.1	-1.961	0.070	-16.3	-1.646	0.034	-6.5	-1.334
1Q Last	0.028	-9.9	-2.262	0.022	-10.6	-1.515	0.062	-9.0	-2.257
1Q First	0.074	-18.7	-2.307	0.084	-23.0	-1.910	0.061	-11.4	-1.767
2Q Last	0.085	-19.3	-2.417	0.084	-23.6	-1.921	0.127	-13.8	-3.042
2Q First	0.074	-20.2	-2.936	0.062	-22.4	-2.185	0.152	-17.5	-2.643
3Q Last	0.089	-23.1	-2.629	0.061	-25.1	-1.604	0.233	-21.4	-2.796
3Q First	0.112	-28.9	-3.131	0.076	-31.8	-1.888	0.255	-26.9	-3.334
4Q Last	0.100	-24.4	-2.826	0.032	-18.2	-0.906	0.277	-28.7	-3.068
4Q First	0.133	-30.6	-3.091	0.037	-23.0	-0.843	0.313	-34.0	-3.385

UNEMP = $\alpha + \beta \cdot$ EXPEND

	Full Sample			Pre-1991			Post-1990		
Horizon	R^2	β	**t-Stat**	R^2	β	**t-Stat**	R^2	β	**t-Stat**
0Q Last	0.000	-0.2	-0.109	0.001	0.8	0.220	0.039	-4.2	-1.793
0Q First	0.017	6.2	1.156	0.064	14.0	1.949	0.045	-7.5	-1.950
1Q Last	0.070	14.1	2.035	0.132	21.7	2.574	0.003	-2.0	-0.589
1Q First	0.198	29.1	3.140	0.327	39.8	4.504	0.000	1.1	0.406
2Q Last	0.270	36.7	3.401	0.382	48.6	4.457	0.046	10.5	2.404
2Q First	0.345	44.0	4.139	0.482	57.0	6.114	0.071	14.5	2.274
3Q Last	0.419	49.1	3.984	0.551	62.7	5.097	0.161	21.8	3.114
3Q First	0.439	52.8	4.352	0.572	66.6	5.713	0.202	27.6	4.228
4Q Last	0.490	53.3	4.676	0.612	67.8	5.530	0.345	36.1	3.706
4Q First	0.528	55.3	4.835	0.674	71.8	5.674	0.390	39.8	4.631

Note: This table reports the results of regressions of Greenbook federal government receipts forecast errors on forecast errors for the variables shown in the table. Estimation is by OLS, with HAC standard errors used to calculate the t-statistics. The number of lags used was equal to $2(h+1)$ where h is the forecast horizon rounded to the nearest quarter. Under the **Horizon** heading, "First" and "Last" indicate whether the forecast was made during the first or last meeting of the quarter.

Consistent with the Greenbook forecasts, measures of inflation and output growth were based on quarter-to-quarter changes expressed at annual rates. We examined all forecast horizons from 0L (nowcasts from the last meeting of the quarter) to 4F (4-quarter-ahead forecasts from the first meeting of the quarter.)

To understand the relationship between fiscal forecast errors and those for headline variables, we simply regressed the latter on the former, considering results for the full sample, the pre-1991 sample and the post-1990 sample. Greenbook forecasts for the output gap and CPI inflation were only available from August 1987 and October 1979 respectively. The resulting lack of degrees of freedom made inference problematic in some cases, particularly in the pre-1991 sample for longer-horizon forecasts of the output gap. In addition, HEB and HEB6 are identical during the period for which we have output gap data; we therefore only consider the gap's relationship to HEB. An earlier version of this paper used shorter series of Greenbook forecasts (available from the Federal Reserve Bank of St. Louis ALFRED database) and core inflation (CPI ex food and energy) data in place of the GDP deflator; results were qualitatively similar.

III. Romer-Romer Regression Detailed Results

We followed the methodology proposed by Romer and Romer (2004) to measure monetary policy shocks by regressing changes in the fed funds rate target on a variety of control factors.[9] The residuals are deemed to represent exogenous changes in policy. We added our fiscal forecasts to investigate how taking account of fiscal variables alters estimates of monetary policy shocks.

We used the Coibion et al. (2012) data set to estimate the relationship over an expanded data sample ending in December 2008 (after which the federal funds rate was at its effective lower bound.)[10]

Table 11 compares estimates from the Romer and Romer (2004) original specification with those that add forecasts of SURPLUS and of HEB in various combinations together with revisions in those forecasts. Because the potential sample period varies slightly depending on the set of variables included, we take care to re-estimate the original Romer and Romer (2004) specification over precisely the sample period used for each of our fiscal variable specifications.[11]

[9] The control variables that they use consist of (1) the level of the federal funds rate target prior to the FOMC meeting, (2) the estimated rate of unemployment, and Greenbook estimates of past, current and future values of (3) inflation and (4) real output, as well as (5 & 6) revisions in these forecasts from those of previous FOMC meeting.

[10] Available at *http : //eml.berkeley.edu/ ygorodni/RR_MPshocks_Updated.xls* .

[11] In choosing the lags to include in the regression, we again follow Romer and Romer (2004) and include lags -1 to 2Q for all variables other than HEB; for the latter we used -1 to 4Q (although our results are robust to this distinction.) We prefered to use slightly longer lags for HEB because we think that *structural* deficits are essentially exogenous with respect to monetary policy shocks over a longer horizon.

Table 11—Revised Estimates of Romer and Romer (2004)

	SURPLUS & ISURPLUS	CGKS 2016	SURPLUS	CGKS 2016	HEB & IHEB	CGKS 2016	HEB	CGKS 2016	SURPLUS & HEB	CGKS 2016
Constant	0.0634	0.0662	0.0656	0.0662	0.0798	0.0686	0.0900	0.0376	-0.2196	0.0376
	0.1386	0.1067	0.1370	0.1066	0.1236	0.1147	0.1151	0.1093	0.2731	0.1093
OLDTARG	-0.0212	-0.0237	-0.0223	-0.0237	-0.0277	-0.0277	-0.0245	-0.0180	-0.0326	-0.0180
	0.0110	0.0105	0.0106	0.0104	0.0119	0.0110	0.0107	0.0103	0.0115	0.0103
GRAYM	0.0112	0.0125	0.0124	0.0125	-0.0019	0.0018	-0.0026	-0.0004	0.0002	-0.0004
	0.0097	0.0096	0.0095	0.0096	0.0115	0.0116	0.0104	0.0107	0.0102	0.0107
GRAY0	-0.0135	-0.0039	-0.0142	-0.0039	0.0169	0.0257	0.0120	0.0221	0.0137	0.0221
	0.0187	0.0175	0.0182	0.0174	0.0218	0.0214	0.0194	0.0199	0.0272	0.0199
GRAY1	0.0260	0.0375	0.0322	0.0375	0.0396	0.0198	0.0325	0.0069	0.0084	0.0069
	0.0298	0.0279	0.0290	0.0278	0.0324	0.0310	0.0289	0.0287	0.0354	0.0287
GRAY2	0.0111	-0.0037	0.0090	-0.0037	-0.0016	0.0047	0.0092	0.0230	-0.0207	0.0230
	0.0277	0.0274	0.0275	0.0273	0.0330	0.0315	0.0303	0.0294	0.0373	0.0294
IGRYM	0.0437	0.0492	0.0479	0.0492	0.0258	0.0395	0.0271	0.0390	0.0214	0.0390
	0.0249	0.0246	0.0243	0.0246	0.0261	0.0264	0.0235	0.0241	0.0233	0.0241
IGRY0	0.1165	0.1272	0.1218	0.1271	0.1236	0.1170	0.1181	0.1164	0.1130	0.1164
	0.0280	0.0263	0.0264	0.0263	0.0282	0.0283	0.0261	0.0268	0.0261	0.0268
IGRY1	0.0105	0.0141	0.0056	0.0141	-0.0091	0.0280	0.0033	0.0348	-0.0160	0.0348
	0.0354	0.0347	0.0349	0.0346	0.0371	0.0367	0.0346	0.0349	0.0349	0.0349
IGRY2	0.0153	0.0192	0.0153	0.0192	0.0271	0.0147	0.0218	0.0019	0.0216	0.0019
	0.0372	0.0374	0.0370	0.0373	0.0403	0.0402	0.0373	0.0380	0.0373	0.0380
GRADM	0.0487	0.0315	0.0461	0.0315	0.0363	0.0333	0.0318	0.0263	0.0536	0.0263
	0.0218	0.0210	0.0215	0.0209	0.0250	0.0243	0.0230	0.0227	0.0233	0.0227
GRAD0	-0.0433	-0.0359	-0.0435	-0.0359	-0.0653	-0.0435	-0.0605	-0.0385	-0.0465	-0.0385
	0.0260	0.0259	0.0259	0.0259	0.0305	0.0294	0.0283	0.0282	0.0281	0.0282
GRAD1	-0.0088	-0.0066	-0.0050	-0.0065	0.0259	0.0044	0.0223	-0.0143	0.0424	-0.0143
	0.0414	0.0412	0.0408	0.0409	0.0495	0.0459	0.0452	0.0432	0.0450	0.0432
GRAD2	0.0642	0.0730	0.0659	0.0730	0.0723	0.0587	0.0726	0.0685	0.0568	0.0685
	0.0451	0.0446	0.0446	0.0445	0.0542	0.0506	0.0498	0.0479	0.0498	0.0479
IGRDM	0.0464	0.0552	0.0526	0.0552	0.0397	0.0379	0.0346	0.0363	0.0477	0.0363
	0.0407	0.0395	0.0393	0.0394	0.0424	0.0418	0.0383	0.0392	0.0382	0.0392
IGRD0	0.0049	0.0135	0.0101	0.0135	0.0361	0.0081	0.0289	0.0108	0.0291	0.0108
	0.0412	0.0408	0.0407	0.0407	0.0436	0.0433	0.0411	0.0419	0.0403	0.0419
IGRD1	0.0625	0.0613	0.0632	0.0613	0.0474	0.0705	0.0372	0.0744	0.0457	0.0744
	0.0649	0.0641	0.0633	0.0640	0.0719	0.0700	0.0657	0.0668	0.0646	0.0668
IGRD2	-0.1473	-0.1300	-0.1449	-0.1300	-0.1058	-0.1322	-0.0954	-0.1205	-0.1142	-0.1205
	0.0740	0.0732	0.0735	0.0731	0.0836	0.0828	0.0776	0.0782	0.0762	0.0782
GRAU0	-0.0379	-0.0440	-0.0400	-0.0440	-0.0588	-0.0396	-0.0596	-0.0383	0.0185	-0.0383
	0.0313	0.0187	0.0311	0.0186	0.0234	0.0207	0.0213	0.0194	0.0396	0.0194
SRPL M01	-8.4043		-8.5304						9.6656	
	4.2433		3.9765						20.1477	
SRPL 00	-7.3188		-5.8525						-60.4329	
	5.3373		4.7182						36.7155	
SRPL 01	13.5040		14.6808						20.0901	
	7.3073		5.7633						44.4706	
SRPL 02	3.1553		0.7122						40.6606	
	6.9425		5.7712						25.9933	
ISRPL M01	3.0387									
	7.7942									
ISRPL 00	7.4556									
	6.9963									
ISRPL 01	2.3266									
	7.9488									
ISRPL 02	-4.2685									
	8.8344									
HEB M01					-7.3803		-6.1673		-14.6633	
					4.4352		3.9521		20.2071	
HEB 00					-4.6960		-2.7018		57.1957	
					5.5640		4.7182		36.7640	
HEB 01					19.7266		21.2228		-2.1303	
					8.2999		5.7527		43.6950	
HEB 02					17.8255		8.7337		-32.9156	
					10.4533		7.8920		26.8726	
HEB 03					-41.6284		-34.9462		-29.8382	
					14.7175		11.6230		11.5905	
HEB 04					12.6160		10.5837		12.6876	
					10.7989		8.6448		8.5900	
IHEB M01					7.1318					
					7.9721					
IHEB 00					4.6585					
					7.4216					
IHEB 01					2.2071					
					8.2223					
IHEB 02					-8.6923					
					10.5454					
IHEB 03					4.8137					
					13.9264					
IHEB 04					-13.4237					
					12.3408					

Note:
OLS regression results for dependent variable *DTARG*—the change in the federal funds rate target. Shown are coefficient estimates (first line) and their estimated standard errors (second line.)
Estimation ends in December 2008, after which the target rate was constrained by the zero lower bound.
CGKS 2016 - Estimates using Romer and Romer (2004) and Coibion et al. (2012) specification
OLDTARG - Federal funds rate target before start of FOMC meeting
GRAY - Greenbook forecast rate of output growth
IGRY - Change in Greenbook forecast rate of output growth from previous FOMC meeting
GRAD - Greenbook inflation forecast
IGRD - Change in Greenbook inflation forecast from previous FOMC meeting
GRAU0 - Greenbook unemployment rate estimate for current quarter
SRPL - Greenbook forecast surplus (deficit) to GDP ratio
ISRPL - Revision in Greenbook forecast surplus (deficit) to GDP ratio
HEB - Greenbook forecast high-employment budget surplus (deficit) to GDP ratio
M, 0 to 4 - forecast horizons (quarters.) *M* indicates estimate for the preceding quarter.

IV. A Fiscal Policy-Influenced Taylor Rule

Simple monetary policy rules, such as the Taylor rule described in Taylor (1993), do not include a variable representing fiscal policy, yet the narrative evidence that we presented in Section II implies that monetary policymakers consider fiscal policy details while determining their policy actions. This raises the question of whether conventional Taylor rules are missing fiscal variables. To examine this possibility, we can use the Greenbook forecasts to estimate a Taylor rule that either excludes or includes forecasts of the overall and the cyclical part of the government budget surplus.

The Taylor rules we estimate take the general form

$$i_t = \rho i_{t-1} + (1-\rho)\hat{i}_t + \epsilon_t.$$

$$\hat{i}_t = \beta' X_t,$$

where X_t is a vector of variables known or forecasts formed at date t. [12] What variables should be included in vector X? The standard Taylor rule includes just the output gap and the difference between the inflation rate and the target for inflation. Empirical estimation assumes that the inflation target is constant over time, so the independent variables in a regression analysis include a constant term, the output gap, and the inflation rate. The other major modeling choice is whether the terms should be observables (lagged output gap and inflation rate) or forecasts (forecasts of output gap and inflation rate), reflecting the forward-looking nature of monetary policy. We show results for the Taylor rule based on observables (data at time $t-1$), current-quarter forecasts, two-period-ahead forecasts, and four-period-ahead forecasts.[13]

If the Fed pays attention to fiscal variables in setting monetary policy, how would those variables be reflected in the Taylor rule? One possibility is that the fiscal variables are useful only for determining the output gap, in which case they should not enter the Taylor rule separately. But it may be that fiscal variables influence monetary policy directly rather than just indirectly via the output gap. In that case, we would expect the addition of fiscal variables to significantly

[12] Rudebusch (2006) finds some evidence favoring rules of the form

$$i_t = \beta' X_t + \nu_t,$$

$$\nu_t = \gamma \nu_{t-1} + \omega_t,$$

where unmodeled shocks ν_t are serially correlated. We estimated several such models and found that they tended to give somewhat similar, albeit weaker, results. While Rudebusch (2006) argues that the two forms are difficult to distinguish empirically, Coibion and Gorodnichenko (2012) present additional evidence that strongly favors the first form presented above. For that reason, we present only those results.

[13] We estimated the rule using 1-quarter-ahead and 3-quarter-ahead forecasts, but do not report these results to conserve space. Those results contribute no additional insights.

improve the fit of the Taylor Rule. To examine this issue, we will estimate the Taylor rule including terms for both the overall surplus (S_{t+k}) and structural surplus ($HEB6_{t+k}$), separately. The results are shown in Table 12.

All of the estimated coefficients on inflation, the output gap and lagged interest rates have the expected sign. The coefficient on i_{t-1} is always strongly significant with coefficient estimates in the range of 0.73 to 0.87, which implies that the Fed reacts to shocks fairly slowly. The coefficients on π_{t+k} are always positive and almost always significant, as we expect. They increase in size as k increases, as we would expect if the Fed reacts more strongly to expected future inflation than to past inflation. Coefficients on the output gap (defined as the level of output minus the level of potential output, expressed as a percentage of the latter) are always of the correct sign and strongly significant.

The two fiscal balance variables are almost always both statistically significant at the 5 percent confidence (the only exception being the case except when $k = 1$ in the last meeting of the quarter for $HEB6$.) The sign on the overall budget surplus is negative, implying that the Fed eases monetary policy when fiscal policy tightens. But the coefficient on $HEB6$ is positive, which implies that a higher structural surplus leads the Fed to *tighten* monetary policy. The introduction of these variables also always raises the coefficient on the output gap and lowers that on lagged inflation, sometimes to the point of insignificance.

If the economy is projected to be at full employment, then $S_{t+k} = HEB6_{t+k}$, so the direction of the fed funds rate would be determined by the sum of the coefficients on S_{t+k} and $HEB6_{t+k}$. In cases where the two coefficients are similar in magnitude but opposite in sign, then this fiscal policy change would have no independent effect on the fed funds rate; the only effect would occur through the indirect effect of fiscal policy on the output gap. For shorter horizons, the magnitude of the coefficient on S_{t+k} is larger in absolute value than that of $HEB6_{t+k}$, which would imply a reduction of the fed funds rate when both surpluses increase by the same amount, so in this case the Fed eases policy in response to structural fiscal tightening.

These results open the door to the possibility that fiscal policy affects monetary policy independently of its effect on the output gap. However, we caution that these results are not robust. In particular, one might argue that $(S_{t+k} - HEB6_{t+k})$, the "cyclical" component of the fiscal surplus, is strongly correlated with the rate of unemployment. In additional tests (not reported here), we found that

1) neither S_{t+k} nor $HEB6_{t+k}$ were statistically significant unless both were included in the regression.

2) when they were statistically significant, the sum of their coefficients was never statistically significantly different from zero.

3) When we replaced the output gap in the regression with the unemployment rate, our fiscal variables were never significant.

TABLE 12—TAYLOR RULE ESTIMATES

	k = -1				k = 0			
	First		Last		First		Last	
Constant	0.247	0.599	0.249	0.440	0.298	0.690	0.260	0.633
	(1.28)	(2.33)	(1.44)	(1.82)	(1.81)	(3.70)	(1.56)	(3.25)
i_{t-1}	0.865	0.836	0.856	0.836	0.815	0.820	0.857	0.864
	(25.3)	(24.5)	(26.6)	(27.1)	(27.3)	(25.7)	(33.2)	(28.1)
π_{t+k}	0.179	0.091	0.195	0.115	0.263	0.136	0.181	0.053
	(3.68)	(1.69)	(4.33)	(1.92)	(3.11)	(1.82)	(2.70)	(0.86)
y_{t+k}	0.138	0.377	0.153	0.359	0.179	0.393	0.164	0.384
	(4.69)	(6.15)	(5.90)	(5.62)	(7.39)	(8.56)	(7.50)	(8.26)
S_{t+k}		-38.2		-31.2		-39.7		-40.7
		(3.40)		(2.44)		(5.72)		(5.23)
$HEB6_{t+k}$		26.9		18.1		32.6		32.3
		(2.57)		(1.47)		(4.62)		(3.94)
$\overline{R}^2$	0.961	0.973	0.964	0.975	0.968	0.980	0.965	0.978
	k = 2				k = 4			
	First		Last		First		Last	
Constant	0.208	0.551	0.181	0.466	0.038	0.513	0.009	0.438
	(1.48)	(2.67)	(1.31)	(2.42)	(0.25)	(2.05)	(0.06)	(1.89)
i_{t-1}	0.733	0.793	0.771	0.821	0.781	0.822	0.809	0.841
	(26.3)	(28.3)	(30.3)	(38.9)	(22.0)	(29.6)	(25.2)	(27.3)
π_{t+k}	0.484	0.268	0.412	0.240	0.458	0.267	0.406	0.261
	(6.50)	(3.04)	(5.82)	(3.88)	(4.34)	(2.44)	(4.49)	(2.57)
y_{t+k}	0.255	0.382	0.223	0.340	0.231	0.402	0.206	0.344
	(8.00)	(7.67)	(7.99)	(7.42)	(5.61)	(5.97)	(6.39)	(5.74)
S_{t+k}		-30.1		-27.4		-34.4		-29.2
		(3.32)		(3.14)		(3.21)		(2.68)
$HEB6_{t+k}$		26.7		24.8		34.3		32.0
		(2.74)		(2.49)		(3.03)		(2.69)
$\overline{R}^2$	0.977	0.981	0.976	0.979	0.973	0.978	0.972	0.975

Note: S_{t+k} refers to the Surplus and $HEB6_{t+k}$ refers to the structural surplus. Coefficients are shown for each variable in the Taylor Rule equation, with t-statistics shown in parentheses below each coefficient. Estimation is by least squares with HAC standard errors. *First* and *Last* refer to the timing of the FOMC meeting within the quarter.

V. Patton-Timmermann Tests

Patton and Timmermann (2012) describe methods for evaluating forecasts at multiple horizons, as is the case for our Greenbook fiscal forecasts. They evaluate a number of different tests but focus particular attention on "optimal revision regression tests" in section 3.3 of their paper. We run those tests for each of the four major fiscal forecast variables (surplus, expenditures, receipts, and HEB). The basic idea of the tests is similiar to the standard Mincer-Zarnowitz test of unbiasedness but expanding the test to include multiple horizons.

One version of the optimal revision regression test examines regressions of either a realized variable on forecasts at different horizons, or regressing the last forecast made on forecasts made at longer horizons. The null hypothesis of rational forecasts requires that the coefficient on the most recent forecast have a coefficient of 1, while the coefficients on the constant term and on earlier forecasts are zero. Table 13 shows the results of these tests, with the p-values in the table showing the joint test of the null hypothesis on the zeroes and ones discussed above.

In the table, when the dependent variable is listed as "Actual," the regression is:

$$Y_t = \alpha + \sum_{j=1}^{H} \beta_j \hat{Y}_{t|t-h_j},$$

where Y_t is the realized (actual) value of Y at date t, and $\hat{Y}_{t|t-h_j}$ is the forecast of Y_t made at date $t - h_j$. The shortest forecast horizon is h_1 and the longest forecast horizon is h_H. The test is for the joint hypothesis that $\alpha = 0$, $\beta_1 = 1$, and all the other $\beta_j = 0$ for $j = 2, 3, ..., H$.

In the table, when the dependent variable is listed as "Last Forecast," the regression is:

$$\hat{Y}_{t|t-h_1} = \alpha + \sum_{j=2}^{H} \beta_j \hat{Y}_{t|t-h_j},$$

The test is for the joint hypothesis that $\alpha = 0$, $\beta_2 = 1$, and all the other $\beta_j = 0$ for $j = 3, 4, ..., H$.

The results show scant evidence of inefficiency in the fiscal forecasts. Only when the most recent forecast is regressed on prior forecasts for the surplus is there a p-value less than 0.05. Given 16 tests, such a single occurrence could be by chance. Thus the tests do not suggest much evidence of inefficiency.

Table 13—Patton-Timmermann Optimal Revision Regression Test

Dependent Variable	Meeting	HEB	Surplus	Expenditures	Receipts
Actual	First	0.057	0.108	0.057	0.514
Actual	Last	0.348	0.180	0.467	0.525
Last forecast	First	0.904	0.012	0.199	0.889
Last forecast	Last	0.541	0.308	0.191	0.486

Note: P-values are shown for the test of the null hypothesis that the first lagged forecast has a coefficient of unity and all the other coefficients on lagged forecasts, as well as the constant, are zero.
Estimation is by least squares.
First and *Last* refer to the timing of the FOMC meeting within the quarter.

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