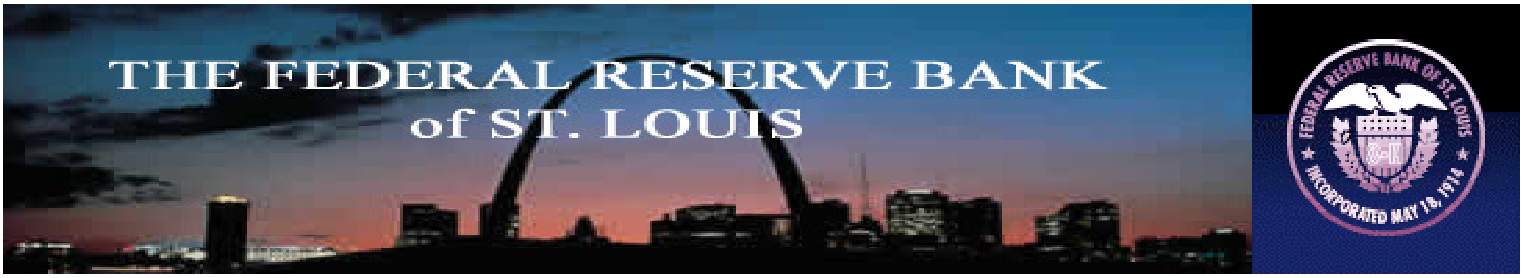

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Do Productivity Growth, Budget Deficits, And Monetary Policy Actions Affect Real Interest Rates? Evidence From Macroeconomic Announcement Data

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DO PRODUCTIVITY GROWTH, BUDGET DEFICITS, AND MONETARY POLICY ACTIONS AFFECT REAL INTEREST RATES? EVIDENCE FROM MACROECONOMIC ANNOUNCEMENT DATA

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Abstract

Real-business-cycle models suggest that an increase in the rate of productivity growth increases the real rate of interest. But economic theory is ambiguous when it comes to the effect of government budget deficits on the real rate of interest. Similarly, little is known about the effect of monetary policy actions on real long-term interest rates. We investigate these questions empirically, using macroeconomic announcement data. We find that the real long-term rate of interest responds positively to surprises in labor productivity growth. However, we do not reject the hypothesis that the real long-term rate of interest does not respond to surprises in the size of the government's budget deficit (or surplus). Finally, we find no support for the proposition that the Federal Reserve has information about its actions or the state of the real economy that is not in the pubic domain and, hence, priced in the real long-term interest rate.

Introduction

Does increased productivity growth or an increase in the projected government budget deficit increase the real long-term interest rate? Do investors re-price the real long-term interest rate in response to surprises in monetary policy actions? Standard real-business-cycle models suggest that an increase in the rate of productivity growth increases the real interest rate (e.g., King, Plosser, and Rebelo, 1988). But economic theory is ambiguous when it comes to the effect of government budget deficits on the real rate of interest. Theoretical models provide different answers to this question, depending on whether government expenditures reflect changes in the timing of taxes and on the budgeting horizon of the debt-financing and tax-paying households (Laubach, 2003). Similarly, little is known about the effect of monetary policy actions on real long-term interest rates. The central bank controls the nominal short-term interest rate and, because of high persistence in the rate of inflation, the real short-term interest rate. But even if the expectations hypothesis of interest rates held true (Campbell, 1995), the actions of the central bank are not "independent" but merely reflect the state of an economy whose rate of real growth mean-reverts over the business cycle (Taylor, 1993). Hence, the real rate of interest responds to surprises in monetary policy actions only if economic agents believe that the central bank knows more about its reaction function or the real economy than they do (Romer and Romer, 2000).

We empirically investigate for the period January 31, 1997, to June 30, 2003, the effects of labor productivity growth, federal government budget deficits (surpluses), and monetary policy actions on the real long-term rate of interest by studying how this rate responds to surprise announcements in these three variables. We measure the real long-term rate of interest by the yield to maturity of the on-the-run (that is, most recently issued) 10-year Treasury inflation-indexed security (TIIS). We gauge surprises in macroeconomic announcements by the difference between the expected and the actually released value of the data series, normalized by the degree of uncertainty surrounding these expectations. Our hypotheses are grounded in the "conventional wisdom," which holds that increases in productivity growth and budget deficits raise the real long-term interest rate; also, the Federal Reserve is widely held to have better knowledge of its reaction function and the state of the economy than outsiders do (Romer and Romer, 2000). Our empirical analysis supports the conventional wisdom only in part. We reject the hypothesis that the marginal investor does not re-price the real long-term rate of interest in response to surprises in the size of the government's budget deficit (or surplus) or in response to monetary policy actions. However, we find evidence that the real long-term rate of interest responds positively to surprises in labor productivity growth. Finally, we do not reject the hypothesis that Federal Reserve communication and surprises in monetary policy actions do not affect the uncertainty surrounding the real long-term interest rate. Taken together, we find no support for the proposition that the Federal Reserve has information about its actions or the state of the real economy that is not in the pubic domain and, hence, priced in the real long-term interest rate.

Related Literature

Several studies point to the effect of increased productivity growth on real interest rates in support of what is implied in standard real-business-cycle models (Blanchard and Summer, 1984; Barro and Sala-i-Martin, 1990). Less conclusive is the evidence of the effect of federal budget deficits on real interest rates. As Engen and Hubbard (2004) point out, the research of the past two decades has delivered mixed results: some studies find a positive effect of budget deficits on real interest rates, and other studies find no effect; Engen and Hubbard themselves document a positive effect.

The studies most closely related to our work are Calomiris et al. (2003), Gürkaynak, Sack, and Swanson (2003), and Kohn and Sack (2003). Calomiris et al. study the response of the real interest rate, as measured by the yield to maturity of the 10-year TIIS, to surprises in 19 macroeconomic data releases, among them the monthly federal budget surplus reported by the U.S. Treasury Department; no measure of surprises in labor productivity or monetary policy announcements is included in the regression. Calomiris et al. find no statistically significant effect on the real interest rate of surprises in the federal budget surplus.

Gürkaynak, Sack, and Swanson analyze the response of the *forward* real interest rate to surprises in macroeconomic data releases and in Federal Reserve monetary policy actions; monetary policy actions are changes to the targeted federal funds rate set by the FOMC (Federal Open Market Committee). The forward rates are derived from the yields of 10-year TIIS. The studied pair of one-year forward rates applies to the 12-month time window between the maturity dates of the on-the-run 10-year TIIS and the 10-year TIIS issued 12 months earlier. Prior to July 2002, and starting in 1997, 10-year TIIS were issued only once a year, in January. This implies that the authors analyze changes to the one-year real interest rate that is expected to prevail at the beginning of a 12-month time window that begins, on average, 8.5 years from the time of the data release. The analyzed time period runs from January 1997 through July 2002 and covers 39 macroeconomic data series, among them the monthly releases of nonfarm productivity (Bureau of Labor Statistics) and federal budget surplus (Department of the Treasury). The authors do not reject the hypotheses that surprises in these productivity and federal budget numbers have no affect on the "long-term equilibrium real rate of interest." In a separate regression, Gürkaynak, Sack, and Swanson study the effect on the same dependent variable of surprises in announced changes of the targeted federal funds rate; again, the authors do not reject the null hypothesis that there is no such influence.

Kohn and Sack (2003) study the effect of Federal Reserve communication on financial variables, but make no attempt to gauge the influence on the *level* of Treasury yields of the Federal Reserve Chairman's speeches and testimonies. Rather, the authors measure the effect of Fed communication on Treasury yield *volatility.* Kohn and Sack investigate the effect that Federal Reserve communication has on various financial variables, using daily observations for the period January 3, 1989, through April 7, 2003. Federal Reserve communication comprises statements released by the FOMC and, since June 1996, congressional testimonies and speeches delivered by the Chairman of the Federal Reserve. Among the financial variables Kohn and Sack analyze are the yields (to maturity) of the 2-year and 10-year Treasury notes; these securities are not inflation-indexed and, hence, these yields represent nominal interest rates. Kohn and Sack find that statements of the FOMC and testimonies of the Chairman of the Federal Reserve have a statistically significant impact on the variance of 2-year and 10-year Treasury note yields; no such effect was found for the Chairman's speeches. We build on Kohn and Sack when studying the effect of Federal Reserve communication on the (conditional) variance of the yield of the 10-year TIIS or, put differently, on the uncertainty that surrounds the real long-term rate of interest.

The Data

Our analysis covers the period from January 31, 1997, to June 30, 2003. The starting date of this time window is determined by the availability of the 10-year TIIS yield; the ending date is determined by the series of macroeconomic data releases provided by Money Market Services (MMS). The dataset comprises for 38 macroeconomic data series median polled forecast values, along with the sample standard deviations of these forecast values. The MMS survey is conducted every Friday morning among senior economists and bond traders with major commercial banks, brokerage houses, and some consulting firms, mostly in the greater

New York, Chicago, and San Francisco areas. Among these 38 variables in the survey, there are three items—CPI, PPI, and Retail Sales—for which there also exists a "core" concept. Whereas the comprehensive items of the CPI and the PPI include food and energy items, the respective core measures do not. For Retail Sales, the narrowly defined concept excludes motor vehicles and parts. In the regression analysis, we do not use the core concepts; this leaves us with 35 macroeconomic variables.[1] Data that were released on days where the markets were closed were moved to the next trading day (the day on which this information was priced in the marketplace).

We relate daily changes in the real long-term rate of interest to the surprise component in macroeconomic data releases. Like Gürkaynak, Sack, and Swanson (2003), we define the surprise component as the difference between the actual and the median forecast values; but unlike these authors (and unlike Calomiris et al.), we normalize these surprises by the sample standard deviation of the individual forecasts. We also control for the surprise component in changes (or the absence thereof) of the targeted federal funds rate, which we measure as suggested by Kuttner (2001) and discussed by Watson (2002). For each scheduled and unscheduled FOMC meeting, we scaled up by $30/(k+1)$ the change of the price of the federal funds futures contract for the current month on the day of the FOMC meeting, t, where $t+k$ denotes the last calendar day of the month.[2] (Note that this variable is not on the same scale as the surprise component in the macroeconomic data releases.) In a sensitivity analysis, we use an alternative measure of the surprise component in monetary policy actions; this alternative measure, devised by Poole and Rasche (2000), rests on price changes of federal funds futures contracts also.[3] Finally, we control for Federal Reserve communication and actions. Our concept of Federal Reserve communication comprises (1) the Fed Chairman's semi-annual testimony to Congress (formerly known as Humphrey-Hawkins Testimony) and (2) speeches and other testimonies of the Fed Chairman. Consistent with the macroeconomic data releases, we moved Federal Reserve communication to the next trading day if this communication occurred after-hours (that is, after the real interest rate had been recorded) or on days on which there was no trading.

Table 1 shows the frequency with which releases of the 38 macroeconomic data series match recorded changes in the real interest rate during the analyzed time period. The difference to the number in parentheses—the number of data releases during the analyzed time period—is due to missing values in the recorded real interest rate. We also report matches for scheduled and unscheduled FOMC meetings—the Federal Funds Target variable, the surprise component of which was calculated as outlined above—and the two Federal Reserve communication variables defined above, which are the Semi-annual Testimonies to Congress and Chairman Greenspan's Speeches and Testimonies Other than the Semi-annual Testimony to Congress. The only weekly series in the dataset, Initial Jobless Claims, has the highest frequency. The next-to-highest frequency is observed for Testimonies Other than Semi-annual Testimony to Congress, followed by monthly data releases, FOMC actions (Federal Funds Target), quarterly data releases, and the Chairman's semi-annual testimonies to Congress. An exception is Nonfarm Productivity, which entered the MMS dataset during the analyzed time period; the first surveyed number refers to the first quarter of 1999.

Table 2, center column, offers a frequency distribution for the coincidence of surprises in macroeconomic data releases (MMS survey) and monetary policy actions. For instance, there are 445 trading days in the analyzed time window of 1,527 trading days on which there were no surprises in data releases or monetary actions, possibly because no data were released or no action taken. There are 600 trading days (39 percent) with more than one surprise and 268 trading days (18 percent) with more than two surprises. Table 2, right column offers a frequency distribution with Federal Reserve communication included.

Empirical Approach and Findings

The empirical approach rests on the following regression equation:

$$(1) \qquad r_t - r_{t-1} = \alpha + \beta \cdot D + \sum_{k=1}^{35} \delta_k \cdot x_t^k + \gamma \cdot ff_t + \varepsilon_t \ ,$$

where $r_t - r_{t-1}$ is change in the real interest rate from trading day $t-1$ to trading day t; D is an indicator variable that is equal to 1 if all explanatory variables are equal to 0 (and is equal to 0 otherwise); x_t^k is the surprise component in the macroeconomic data release; ff_t is the surprise component in the Federal Reserve action (the Federal Funds Target variable); and ε_t is an error term.[4]

The change in the real long-term interest rate is measured by the daily change in the on-the-run 10-year TIIS yield. Chart 1 shows a kernel estimate of the distribution of this dependent variable (thick line), along with a frequency distribution (candlesticks) and a normal distribution based on the sample moments. The change in the real interest rate exhibits statistically significant excess kurtosis (5.164) and mild but statistically significant skewness (0.401); excess kurtosis means that, compared with the normal distribution, there is excess probability mass in the center of the distribution.[5]

Regression equations with large sets of explanatory variables are prone to rejecting for individual variables the null hypothesis that there is no economic influence. In a regression with one (non-constant) explanatory variable, the probability of erroneously rejecting the null for a single (non-constant) variable equals the applied significance level, e.g., 10 percent. When there are 36 (non-constant) explanatory variables (35 announcement variables and the fed funds surprise measure) and none of them has an economic impact on the dependent variable, then the probability of erroneously rejecting the null for at least one of these variables equals 98 percent.

Hence, it is almost inevitable that the null is rejected for at least one of the 36 variables even if none of these variables merits such rejection—erroneous rejections harbor the risk of "rationalizing" statistically significant regression outcomes.

An econometric approach called stepwise regression has been suggested as a remedy to the problem of erring on the side of rejecting the null for individual variables when the number of explanatory variables is large. In stepwise regression, all variables of interest are included in a first-step regression. Then, in a second-step regression, only variables that proved statistically significant in the first step enter the regression equation. The downside of stepwise regression is that traditional statistical tests (e.g., *t*-tests on individual variables) in the second-state regression are invalid because these variables were chosen on the basis of their statistical significance in the first-stage regression; for details see Greene (2000, p. 334).

Our approach to the risk of erring on the side of inclusion (and rationalizing "statistical findings") is to restrict the hypothesis testing to three explanatory variables: surprises in labor productivity (output per hour) growth, in federal budget deficits (or surpluses), and in monetary policy actions. The probability of erroneously rejecting the null for at least one of these three variables when, in fact, none of them merits it equals 14 percent (for a significance level of 5 percent in one-tailed tests). Although we are interested in these three variables only, we include all trading days in the regression; most of these trading days do not record an observation for any of these three variables. We include all trading days because on days when there are announcements concerning at least one of the three variables of interest, there may be other macroeconomic announcements as well; in order to obtain a high degree of efficiency in estimating the parameters of these other variables (and hence of the parameters of the three variables of interest), all trading days should be included on which observations of these other variables are recorded, and so forth.

Table 3 shows the results of regression equation (1); there are traditional *t*-values and, because of the excess kurtosis of the dependent variable, significance levels obtained from distribution-free bootstrap-*t* intervals (see Efron and Tibshirani, 1993). The regression coefficients of interest are those of Nonfarm Productivity (Preliminary)—the preliminary nonfarm productivity number is the originally released number before it is possibly revised—Treasury Budget (Surplus), and Federal Funds Target. Only for the quarterly releases of nonfarm productivity data we can reject the null hypothesis that surprises in the announcement have no impact on the real long-term rate of interest. Surprises in the monthly releases of the size of the budget deficit (or surplus) and surprises in changes of the targeted federal funds rate have no discernable impact on the real rate of interest.

Poole, Rasche, and Thornton (2002) argue that monetary policy surprises as gauged by changes in federal funds futures prices are measured with error. This is because federal funds futures prices not only change in response to monetary policy actions, but also respond to other information pertinent to the future path of the federal funds rate. Because of the measurement error introduced by such ambient price changes of federal funds futures contracts, the regression coefficient of the Federal Funds Target variable is biased toward 0. We account for this error-in-variable problem with an instrumental-variables approach. As an instrument for Federal Funds Target, we use an indicator equal to 1 if Federal Funds Target exceeds its median positive value, equal to -1 if it falls short of its median negative value, and 0 otherwise.[6]

Table 4 shows the regression results of the instrumental-variables approach applied to equation (1). We use two alternative definitions of the surprise component of monetary policy actions (the Federal Funds Target variable). First, we provide results for the concept that we used above—the measure suggested by Gürkaynak, Sack, and Swanson (2003), which is denoted Federal Funds Target (GSS) in the table. Second, we present results for the surprise measure devised by Poole and Rasche (2000); this measure is denoted Federal Funds Target (PR) in the table. Unlike the GSS measure, which rests on the scaled price change of the current month's federal funds futures contract (unless the monetary policy surprise happens within the last seven days of the month), the PR measure always uses the price change of the next month's federal funds futures contract. For the GSS measure, the regression coefficient for the Federal Funds Target variable is indeed larger (in absolute value) than it is without the error-in-variable correction (shown in Table 3) but remains statistically insignificant. But for the PR measure, the regression coefficient for the Federal Funds Target variable is smaller (in absolute value) than it is without the error-in-variable correction (not shown); it remains statistically insignificant as well.

To this point, we were unable to establish evidence that monetary policy actions of the Federal Reserve affect the real long-term rate of interest. But the Federal Reserve has another channel of influence—communication. As discussed above, the surprise component in Federal Reserve communication is next to impossible to ascertain. Yet, following Kohn and Sack (2003), we can analyze the effect of Federal Reserve communication on the (conditional) variance of the dependent variable; this variance may be viewed as a measure of uncertainty that surrounds the future path of real short-term interest rates. Note that, if Federal Reserve communication and surprises in monetary policy actions affect the uncertainty surrounding the real rate of interest, then the error term of the regression equation (3) is heteroskedastic; Rao's score test on heteroskedasticity indeed rejects the null hypothesis that there is no such heteroskedasticity.[7]

We study the impact of Federal Reserve communication and surprises in monetary policy action on real-interest-rate uncertainty by analyzing the squared residuals from regression equation (1)—as shown in Table 3—in an estimation approach suggested by Amemiya (1977, 1978). We regress these squared residuals on the (absolute value of the) Federal Funds Target variable, an indicator variable that is equal to 1 on days when Federal Reserve communication was priced in the market (and 0 otherwise), and the previously introduced intercept indicator variable (*D*). The regression results, which are presented in Table 5, indicate that neither Federal Reserve communication nor monetary policy surprises influence the conditional variance of the real rate of interest. Hence, we do not reject the hypothesis that neither surprises in Federal Reserve monetary policy action nor Federal Reserve communication affects the uncertainty surrounding the real long-term interest rate.

Conclusion

We tested three hypotheses concerning the determinants of real long-term interest rates using data on macroeconomic announcements. Although it is widely held that budget deficits increase the real rate of interest, our study of surprises in macroeconomic data releases finds no evidence supporting this hypothesis. Further, we find no evidence supporting the proposition that Federal Reserve communication or surprises in monetary policy actions—as gauged by changes in the targeted federal funds rate—influence the expected value or variance of the real long-term interest rate. These results agree with Gürkaynak, Sack, and Swanson (2003), who find no evidence that the real forward rate—the "long-term equilibrium real rate of interest"—responds to surprises in the federal budget deficit or monetary policy actions.

Unlike surprises in budget deficits and monetary policy actions, surprises in productivity growth matter for the real long-term interest rate. The greater the surprise in the released nonfarm productivity growth number, the greater is the accompanying increase in the real long-term rate of interest. This finding agrees with predictions derived from standard real-business-cycle models, which show that an increase in the rate of productivity growth increases the real rate of interest.

[1] We find no difference in terms of statistical significance for any of our statistical analyses between the core and the comprehensive concepts.

[2] Following Gürkaynak, Sack, and Swanson (2003), we use the (unscaled) change in the price of the federal funds futures contract due to expire in the following month if the FOMC meeting took place within the last seven calendar days of the month.

[3] For a discussion of measures of market expectations concerning monetary policy actions, see Gürkaynak, Sack, and Swanson (2002).

[4] The intercept indicator variable, D, eliminates the influence on the observed mean of the dependent variable of those observations for which none of the explanatory variables contains information pertinent to the measured inflation compensation.

[5] We use a Gaussian kernel along with an (under the null of normal distribution) optimal bandwidth of $(4/3)^{0.2} \cdot \hat{\sigma} \cdot T^{-0.2}$, where T is the number of sample observations and $\hat{\sigma}$ is the sample standard deviation (Silverman, 1986).

[6] For details on this error-in-variable approach, see Greene (2003).

[7] For Rao's score test, see Amemiya (1985).

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Table 1: Number of Data Releases that Match Inflation Compensation Observations

Data Series	Match Frequency
Auto Sales	77 (68)
Business Inventories	77 (67)
Capacity Utilization	77 (67)
Civilian Unemployment Rate	77 (67)
Construction Spending	77 (72)
Consumer Confidence	77 (69)
Consumer Credit	77 (72)
Consumer Price Index (CPI-U)	77 (74)
CPI Excluding Food and Energy (CPI-U, "Core")	77 (74)
Durable Goods Orders	77 (69)
Employment Cost Index (Q)	25 (25)
Existing Home Sales	61 (56)
Factory Orders	77 (72)
Federal Funds Target: Unscheduled FOMC Meeting	4 (4)
Federal Funds Target: Scheduled FOMC Meeting	52 (50)
GDP Price Index (Advance) (Q)	26 (26)
GDP Price Index (Preliminary) (Q)	26 (22)
GDP Price Index (Final) (Q)	26 (23)
Goods and Services Trade Balance (Surplus)	77 (74)
Chairman's Speeches and Testimonies	145 (137)
Hourly Earnings	74 (63)
Housing Starts	77 (73)
Industrial Production	77 (67)
Initial Jobless Claims (W)	334 (306)
Leading Indicators	78 (73)
Purchasing Managers Index (PMI)	77 (65)
New Home Sales	78 (74)
Nonfarm Payrolls	77 (66)
Nonfarm Productivity (Preliminary)	17 (16)
Nonfarm Productivity (Revised)	17 (17)
Personal Consumption Expenditures	78 (62)
Personal Income	78 (62)
Producer Price Index (PPI)	77 (67)
PPI Excluding Food and Energy ("Core")	77 (67)
Real GDP (Advance) (Q)	26 (26)
Real GDP (Final) (Q)	26 (22
Real GDP (Preliminary) (Q)	26 (23
Retail Sales	77 (72)
Retail Sales Excluding Autos ("Core")	77 (72)
Treasury Budget (Surplus)	77 (71)
Truck Sales	77 (68)

Note: Variables not included in the dataset of macroeconomic data releases are italicized. Monthly series if not indicated otherwise (Q: quarterly; W: weekly). Numbers in parentheses indicate total number of observation, not all of which are used because of missing observations for the measures of inflation compensation.

Table 2: Frequency Distribution of Concurrence in Surprises

Number of Surprises per Trading Day	MMS Survey and Federal Funds Target	MMS Survey, Federal Funds Target, and Federal Reserve Communication
0	445	410
1	482	478
2	332	343
3	147	159
4	82	94
5	21	24
6	12	12
7	3	3
8	1	2
9	2	2
Total	1,527	1,527

Table 3: On-the-Run 10-year TIIS Yield and Data Surprises

Explanatory Variable	Coefficient	*t*-Statistic	Bootstrap
Auto Sales	$-2.715 \cdot 10^{-3}$	-0.948	
Business Inventories	$-4.176 \cdot 10^{-3}$	-2.114**	**
Capacity Utilization	$1.476 \cdot 10^{-4}$	0.056	
Civilian Unemployment Rate	$-2.471 \cdot 10^{-3}$	-1.587	
Construction Spending	$-7.883 \cdot 10^{-4}$	-0.486	
Consumer Confidence	$1.184 \cdot 10^{-3}$	0.730	
Consumer Credit	$1.425 \cdot 10^{-3}$	1.210	
Consumer Price Index (CPI-U, "Core")	$-3.002 \cdot 10^{-3}$	-1.245	
Durable Goods Orders	$4.171 \cdot 10^{-4}$	0.379	
Employment Cost Index	$4.972 \cdot 10^{-3}$	1.978**	*
Existing Home Sales	$1.921 \cdot 10^{-4}$	0.237	
Factory Orders	$-1.467 \cdot 10^{-4}$	-0.051	
Federal Funds Target	$7.257 \cdot 10^{-2}$	1.075	
GDP Price Index (Advance)	$6.833 \cdot 10^{-4}$	0.388	
GDP Price Index (Preliminary)	$1.748 \cdot 10^{-3}$	2.456**	**
GDP Price Index (Final)	$-1.595 \cdot 10^{-3}$	-0.880	
Goods and Services Trade Balance (Surplus)	$-1.039 \cdot 10^{-3}$	-0.530	
Hourly Earnings	$-8.496 \cdot 10^{-4}$	-0.520	
Housing Starts	$3.213 \cdot 10^{-4}$	0.165	
Industrial Production	$4.051 \cdot 10^{-3}$	1.028	
Initial Jobless Claims	$-2.009 \cdot 10^{-3}$	-3.103***	***
Leading Indicators	$9.660 \cdot 10^{-3}$	1.395	
Purchasing Managers Index (PMI)	$2.855 \cdot 10^{-3}$	1.226	
New Home Sales	$-2.990 \cdot 10^{-3}$	-1.739*	*
Nonfarm Payrolls	$3.840 \cdot 10^{-3}$	3.057***	***
Nonfarm Productivity (Preliminary)	$5.764 \cdot 10^{-3}$	2.263**	*
Nonfarm Productivity (Revised)	$-3.469 \cdot 10^{-3}$	-0.818	
Personal Consumption Expenditures	$-3.529 \cdot 10^{-3}$	-0.848	
Personal Income	$-2.310 \cdot 10^{-3}$	-0.773	
Producer Price Index (PPI, "Core")	$-9.685 \cdot 10^{-5}$	-0.050	
Real GDP (Advance)	$1.695 \cdot 10^{-3}$	0.690	
Real GDP (Preliminary)	$-3.731 \cdot 10^{-3}$	-1.282	
Real GDP (Final)	$-5.376 \cdot 10^{-3}$	-1.498	
Retail Sales, excluding Motor Vehicles and Parts ("Core")	$-2.279 \cdot 10^{-4}$	-0.094	
Treasury Budget (Surplus)	$-2.545 \cdot 10^{-3}$	-0.958	
Truck Sales	$2.776 \cdot 10^{-3}$	0.847	
Intercept Indicator Variable (*D*)	$1.724 \cdot 10^{-3}$	1.062	
Intercept	$-1.342 \cdot 10^{-3}$	-1.212	
F-statistic (1)	2.147***		
F-statistic (2)	2.216***		
R^2	0.051		
R^2 adj.	0.027		
Ljung-Box Statistic	3.323		
Rao's Score Test	13.63***		
Number of Nonzero Observations	1,082		
Number of Observations	1,527		

Note: ***/**/* Significant at the 1/5/10 percent level, respectively (*t*-tests are two-tailed). *F*-statistics and *t*-statistics are Newey and West (1987) corrected. Federal Funds Target is not included in the MMS survey. *F*-statistic (1): all MMS survey variables and Federal Funds Target; *F*-statistic (2): all MMS survey variables. The number of nonzero observations indicates the number of trading days where there was a surprise in a macroeconomic data release or a monetary policy action priced in the market.

Table 4: Instrumental-Variables Approach

Explanatory Variable	Coefficient	t-Statistic	Bootstrap
Federal Funds Target (GSS)	$1.281 \cdot 10^{-1}$	1.517	Not significant
Federal Funds Target (PR)	$1.185 \cdot 10^{-1}$	1.538	Not significant

Note: Neither regression coefficient is statistically significant (t-tests are two-tailed; t-statistics are Newey and West (1987) corrected). GSS and PR indicate the federal funds market measure for monetary policy surprises as suggested by Gürkaynak, Sack, and Swanson (2002) and Poole and Rasche (2000), respectively.

Table 5: Uncertainty about Real Interest Rates

Panel A: GSS Measure of Fed Funds Target Surprises

Explanatory Variable	Coefficient	t-Statistic	Bootstrap
Federal Reserve Communication	$-2.217 \cdot 10^{-4}$	-0.493	
Federal Funds Target	$4.209 \cdot 10^{-3}$	0.689	
Intercept Indicator Variable (D)	$-4.828 \cdot 10^{-4}$	-1.056	
Intercept	$1.243 \cdot 10^{-3}$	2.774***	**
Number of Nonzero Observations	180		
Number of Observations	1,527		

Panel B: PR Measure of Fed Funds Target Surprises

Explanatory Variable	Coefficient	t-Statistic	Bootstrap
Federal Reserve Communication	$-1.139 \cdot 10^{-4}$	-0.265	
Federal Funds Target	$5.118 \cdot 10^{-3}$	0.653	
Intercept Indicator Variable (D)	$-3.759 \cdot 10^{-4}$	-0.859	
Intercept	$1.137 \cdot 10^{-3}$	2.657***	*
Number of Nonzero Observations	182		
Number of Observations	1,527		

Note: ***/**/* Significant at the 1/5/10 percent level (t-tests are two-tailed). GSS and PR indicate the federal funds market measure for monetary policy surprises as suggested by Gürkaynak, Sack, and Swanson (2002) and Poole and Rasche (2000), respectively. The variable Federal Reserve Communication equals 1 on trading days on which the Chairman of the Federal Reserve's semi-annual testimony to Congress (formerly known as Humphrey-Hawkins Testimony) or speeches and other testimonies of the Fed Chairman were priced in the market. The number of nonzero observations indicates the number of trading days where there was a surprise in a macroeconomic data release or a monetary policy action priced in the market.

Chart 1: Distribution of Daily Changes in the Real Long-Term Interest Rate